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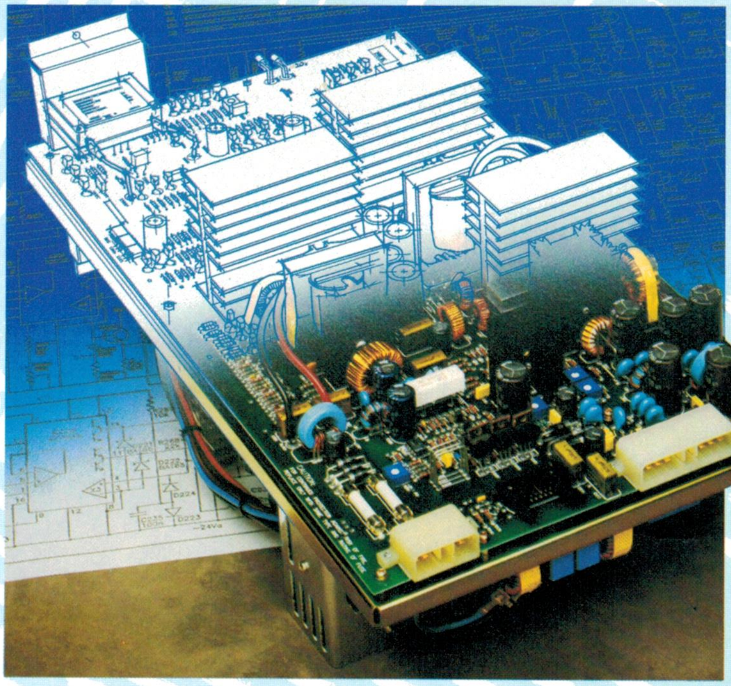

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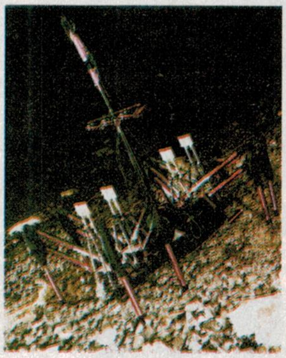
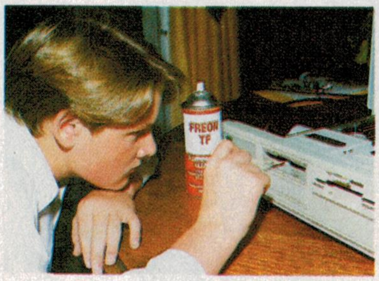
Dante's aborted descent



Although NASA was ultimately forced to abort its project to send the eight-legged walking robot Dante down into the crater of Antarctica's live volcano Mt Erebus, quite a lot of things were learned nonetheless. Kate Doolan explains, in her story starting on page 24.

Rehabilitating old PCs...



An old PC, XT or AT computer may not be up to running Windows, but it can still be very useful — providing you can maintain it properly. Tom Moffat tells you how, in his 'hands on' article starting on page 20.

On the cover

Some of the more impressive late-model electronics products: The Philips DCC130 personal DCC player, held by Australia's triple aerobics champion Sue Stanley; Hewlett-Packard's new 'Benchlink' software and 500MHz DSO; and UPI's measurement transducers.

Video and Audio

Features

Projects and Technical

Volume 56, No.1
January 1994

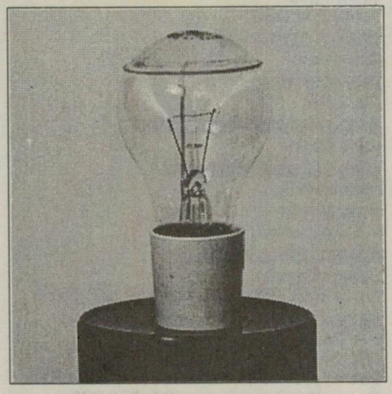
1994 DIGEST ISSUE

Professional Electronics

Columns and Comments

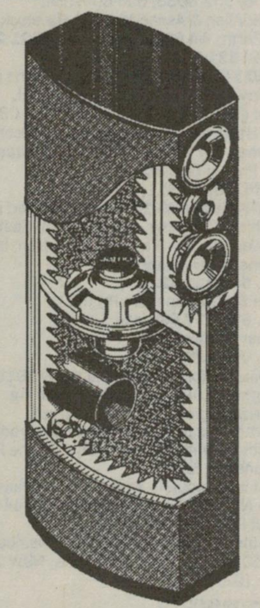
Departments

Low cost plasma ball



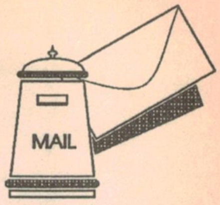
Always wanted one of those plasma ball displays, but found them too expensive? Peter Phillips explains how you can build one yourself, using a normal incandescent lamp globe and a simple EHT supply, in his article starting on page 58.

Jamo's affordable 705



This month Louis Challis has been testing one of the new 'affordable' speaker systems from Danish firm Jamo — the elegant 705 system. His review begins on page 12.

LETTERS TO THE EDITOR



STD-bar circuit

Murray Bacon's 'Telephone STD bar' circuit which appeared in Circuit and Design Ideas (October issue) is very interesting, but it must be pointed out that it does contain a serious flaw in its design. While detecting a zero being dialled first will prevent an STD call being made, it will also prevent any calls to the '000' emergency number being made — with possible disastrous consequences.

Not only this, but calls to 008 numbers or some of the Telecom services such as directory assistance would not be possible.

While the manual bypass switch SW2 could be mounted in a prominent position for emergency calls, this would allow anyone to operate it to gain access to STD. This circuit would really need considerable development to make it a satisfactory device, and any readers considering construction of this unit should be made very aware of the above situation.

Graeme Goodacre,
Tamworth, NSW

Job needed

I came to Australia recently as a permanent resident and have a difficulty finding a job in the area of electronic engineering. I would like to ask your readers to help me.

I am a native of Japan. I have been an enthusiast of electronics and amateur radio operator since I was a teenager, for over 20 years. Although I wanted to study electronics engineering at university, I had to study materials engineering because of a problem in my family.

In 1983 I came out to Australia to do the PhD course in materials engineering for the same reason. After completing the course I went out to United States to take up the position of postdoctoral in chemical engineering in 1988 and came back to Australia in this June. For the final two years during the stay in US, I was not able to study materials engineering properly due to insufficient funding so I was studying electronics on my own. Actually I attempted to enter the undergraduate course in electronics there but I could never afford to do that.

Despite my continuous attempts I have been unsuccessful in getting a position in electronics industry, just because of the lack of formal qualifications. For the time being I will not be able to go to Uni or TAFE since I do not have enough money and have my family to support (currently I am getting modest amount of money from Social Security and sporadic translation jobs). I am ready to be located anywhere in Australia.

It will be greatly appreciated if any reader of *EA* could kindly contact me for assistance.

Sammy Yoshioka,
7/43 Smith Street,
Charlestown, NSW 2290

Buying Oz products

I write to add my 'two-cents-worth' on a remark by Tom Moffatt in his 'Madhouse' column in the November '93 issue, where he commented on having to review a piece of equipment by an Australian manufacturer for some other magazine (not *EA*), a number of years ago. He was specifically instructed to 'tip a bucket on it' by the unnamed magazine (hopefully, he didn't comply with those orders). The last thing anyone should be doing in this country is tipping buckets on 'home-grown' industries. We should, instead, be giving them all the encouragement we can, that they should expand and develop and thus become a source of steady employment for Australians — and help reduce that obscene 11% unemployment rate.

Once upon a time, Australia had a thriving consumer electronics industry, producing TV sets, radios, stereograms and the like; but today we have none of that. All our consumer goods like CD players, VCR's, colour TV's, stereo systems etc., are manufactured in either Asia or Europe and imported into Australia. Which is a crying shame, as we should be manufacturing these sorts of consumer goods ourselves instead of relying on imports.

The only thing Australian about my VCR is its brand-name, AWA.

The product itself is made by Mitsubishi and while it's an excellent unit, it would have been much better if it had been locally made.

At the moment there is a big push to 'buy Australian' but how can we when 100% of our consumer goods (electronic,

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that is) are imported? Considering the cost of these items to buy, Australian-made goods may be a bit more expensive but at least the money wouldn't be going out of the country as it does now with the imported goods.

Neil Forbes,
Stockton, NSW

Safety is profit

Your description of the expatriate Dr Crowcroft as an 'ex patriot' (Forum Oct 93) is, although I suspect a typo, apt.

His thesis that Australia values safety over economic survival appears to me to be the mindless repetition of the gospel according to the economic rationalists (so-called). His dismissal of speed cameras as 'hidden taxation' is arrant nonsense. The introduction of these law enforcement tools has been accompanied by a significant drop in road deaths with an attendant drop in cost to the community. Is he seriously suggesting that traffic rules are an unwarranted intrusion by the 'plethora of civil servants' into the citizen's free choice?

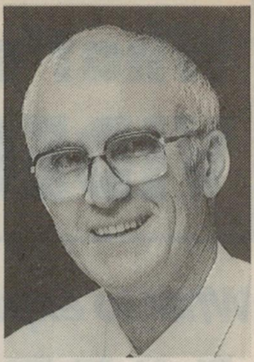
It does not appear to have entered Dr Crowcroft's head that he was able to acquire an education because the government paternalism he so decries prevented — as one example — him from suffering from chronic lead poisoning, because the public health measures included a prohibition against the painting of toys etc., with lead-based paints. Perhaps he ought to read some of the history of public health.

It seems to me that the good Dr (and his friends) have lost the plot. When it is all boiled down the dollar (or yen or rand or pound or ecu) is a tool society uses to manage its affairs, not the be-all and end-all. Certainly not a thing which is of greater value than human life and health.

I would venture to suggest that the self-centred view of the world proposed by Dr Crowcroft, a view which says 'What I want is the most important thing', is a much greater threat to Australia's survival than any safety rules. We certainly do need to do things better, but the improvement in what and how we do it will only come about when we all accept our responsibility as citizens to 'jump in and do' rather than emulating Dr Crowcroft in the great Australian cringe.

Ken Anderson,
Sale, Vic.

EDITORIAL VIEWPOINT



The year of the 'multimedia' computer...

Well, here we are again at the start of another new year. The recession finally seems to be starting to lift, and 1994 looks set to bring rather more 'action' on the electronics scene than the fairly quiet year we've just ended. Although most of the people I've spoken to in the traditional 'consumer electronics' area are still expecting only very slow growth, and much the same seems to apply in the industrial and measurement areas, there are signs that at least one segment of the electronics industry is building up to a phase of dramatic growth.

I'm talking here about the 'multimedia computer' area, which includes not only personal computers with sound, CD-ROM drives and video, but also dedicated video games and CD-I/video CD players. Plus the software/firmware to run on them all, of course.

The developments which have begun to take place in this area are really very impressive. Add a low cost sound card and CD-ROM drive to your 386 or better PC, and you can already buy software which can turn it into an entertainment/education system — capable of dazzling you with its high-resolution pictures and near-CD quality sound. You can also get video, although as yet it's fairly low in resolution and often less than full speed.

I've been trying out some of the current hardware and software for myself, and it's a real eye-opener. There's no doubt that the potential is staggering, for a whole new approach to the way we learn things as well as the way we're entertained — combining still and moving pictures, sound and non-linear interactive text material in almost limitless ways.

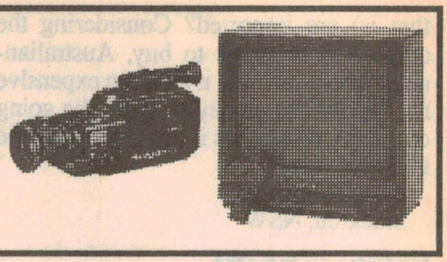
When compressed digital video is fully developed, as it's likely to be this year, this whole field is likely to explode. It may be another year or two before we see dedicated video CD players in the stores, and before Pay-TV finally struggles into Australian homes, but in the meantime the technology to turn our PCs into multimedia information machines is already here, and well advanced.

As usual, the software is lagging a bit behind the hardware, but there's more and more becoming available, and some of the stuff that's already available on CD-ROM is very impressive indeed. For example, try experiencing the Waite Group's *Walkthroughs and Flybys*, a virtual reality demo — or Midisoft's *Music Mentor*, an interactive music teaching program. I gather some of the latest '3D' video games are also very impressive.

This whole area is very exciting, and here at *EA* we'll try to help you keep abreast of the developments as they take place. 1994 certainly looks like being an interesting year, in terms of PC-based multimedia alone...

Jim Rowe

What's New in VIDEO and AUDIO



What to expect in the coming year

Yes, it's that time again. In the January issue each year, we try to give you a few educated guesses about the developments which might take place during the following year, in the fields of video and audio.

Looking back for a moment at our 1993 predictions, we didn't score too badly. We said we though it unlikely that Pay-TV would get going in Australia, and it didn't. We were not too confident about Laserdiscs finally getting under way, either, and that turned out to be true as well.

We predicted a modest growth in the big-screen TV, 'home cinema' and surround-sound markets (which are closely related, of course), and this too seems to have been fairly true. We were even right with our prediction that the days looked to be numbered for Europe's D2MAC/HDMAC system for HDTV.

The area where we did strike out was in predicting a full-on battle for supremacy between the two new media offering compressed digital audio: the Philips DCC (digital compact cassette) and Sony's MD (mini disc). Although both are certainly now available and competing in the market, the 'battle' has turned out to be something of a damp squib — at least in the local market. Neither system seems to have taken the market by storm, perhaps because of buyer resistance arising from the ongoing recession.

Now let's try to look ahead into 1994, and see if we can predict what might happen this time around.

Is it likely we'll see Pay-TV finally get going here? It's possible, perhaps, but to be honest we doubt it. As this is being written, there still seems to be some doubt about the financial backing for the organisation which finally won the main operating licence (after a sequence of events which were truly incredible, even compared with previous spectrum licensing fumbles in Australia). So it seems unlikely that they could set up an infrastructure for satellite-based digital Pay-TV broadcasting, before the end of 1994.

What about other forms of delivery, such as optical fibre or the ADSL system of using conventional telephone cables? Well, some of the organisations which missed out on a satellite licence are certainly looking into these technologies, and the chips needed for low-cost decoding of compressed digital video now seem likely to be available before the middle of the year. But to be realistic, these technologies will probably need rather longer times to set up their distribution and subscriber management systems, compared with satellite delivery. The Federal Government seems determined to hold them back, in any case.

The chances of our seeing broadcast HDTV don't seem all that bright, either — although in this respect, at least, Australia isn't much behind most other countries. Now that the world has effectively decided on a digital future for all kinds of TV, it's likely that HDTV won't be a reality for another couple of years.

On the other hand, it *is* looking increasingly likely that video CD's may well have made their debut before the year is out. There's a huge amount of activity going on in development labs around the world, to bring this system to market. It too uses the low cost decoder chips that have been developed for MPEG digital video, and the discs can be duplicated at low cost by existing CD production plants. So if you've been thinking about buying a new VCR or Laserdisc player, it might be a good idea to wait a while...

Another related area where we are also likely to see rapid developments is CD-ROM based interactive video games, using systems like that developed by the 3DO group in the USA. Early versions of these are already available, and there are strong rumblings that improved versions offering quite staggering levels of video resolution and game complexity are on the way. We wouldn't be at all surprised if these products really 'take off' in 1994.

Some of the new CD-based video game players are likely to offer the facility to play video CDs as well — a combination which is likely to have strong consumer appeal.

What about the current analog Laserdiscs? With video CD's now definitely

Sony amps for audiophiles

Sony Australia has released two new amplifier models to complement its extensive range of hifi components. The TA-F242 and TA-F442E both feature Sony's 'Spontaneous Twin Drive' (STD) power supply in which the power supplies for the pre-amplifier and power amplifier are separated, allowing more power for bass response and better stereo imaging.

The TA-F242 is a 60 watt RMS per channel integrated amplifier with source direct, tone controls, five inputs including the tape monitor, loudness control and A, B and A+B speaker switching.

The TA-F442E is an 80 watt per channel integrated amplifier specially designed for the British and Australian 'audiophile'. Unlike many other Sony amplifiers, the TA-F442E has no tone controls — allowing a direct path from input to output. The TA-F442E also features a toroidal power transformer for high current output, has six inputs including tape monitor and A, B and A+B speaker switching.

The Sony TA-F242 and the TA-F442E are available now. Sony's recommended retail price is $499 and $699, respectively.

on the horizon, we'd guess these are now never likely to flourish in Australia.

Finally, what *is* likely to happen with DCC and MD, this year? Well, assuming the recession is finally starting to lift — albeit slowly — 1994 might see them finally slug it out in earnest. Like many other observers we can't see them both surviving, even if we move rapidly into a 'boom time' for consumer electronics.

Both systems provide near-CD reproduction quality from a compact low-cost medium, of course, and they each offer attractive features. But if we have to stick our neck out and guess which one might emerge triumphant, we'd put our money on MD. It offers faster random track accessing and the potential for greater reliability (due to optical readout), and also looks set to break into the personal computer market as a 140-megabyte successor to the floppy disk.

We could be wrong, of course. It should be interesting to see what happens, shouldn't it?

Kenwood's compact subwoofer for cars

Kenwood Electronics, one of Australia's largest suppliers of car audio, has announced a subwoofer and dedicated subwoofer amp combination that is claimed to 'make the car floor move, if not the earth.' Subwoofer drivers have traditionally been large (10" or more) and mounted behind the back seat, but Kenwood's KSC-W800 stand-alone enclosure is more reminiscent of a letterbox than a chunky subwoofer system, and Kenwood aptly named the KSC-W800 the 'Letterbox'.

Measuring only 252 x 267 x 400mm, the KSC-W800 can be mounted behind the seat, on the van floor, in the boot or in a reasonably small area. However, the size is about the only thing small about this unit.

The Letterbox is a bass reflex design that employs what Kenwood call a spherical flow duct — in fact a tapered port vent to enhance low frequency response down below 40Hz. Couple that to reasonably high efficiency (90dB) and you have a subwoofer system that will deliver 'thunderous' bass material without missing a beat. Designed to be used as a single unit or in multi-subwoofer set-ups, the Letterbox can handle bass material up to 200 watts.

To drive the subwoofer, Kenwood market the KAC-714 mono power amplifier. Although classified as a 100-watt amp, the KAC-714 is capable of peaks around 200 watts. Measuring only

280 x 50 x 170mm, the KAC-714 can fit snugly in most boots. A built-in crossover offers variable frequency cutoff, from below 30Hz to 200Hz and an input gain control to match the correct sound levels to other speakers.

The Letterbox subwoofer has an RRP of $399 and the KAC-714 mono power amp $349. Both units are covered by a 12 month parts and labour warranty. For further information on Kenwood car audio products and your nearest Kenwood car audio dealer, phone 008 066 190.

First personal DCC player

Priced at $999 RRP, the Philips DCC 130 stereo headphone portable player has crashed through the $1000 resistance barrier — for a personal portable music system.

And as the first 'outdoors' DCC player, the DCC130 reinforces the three advantages of the digital compact cassette — the portability and convenience of the cassette, sound quality comparable to CD, and a system that can also play normal audio cassettes.

"The launch of the DCC 130," says Leigh Robinson, Philips Consumer Products group general manager, "is the signal for our positioning of DCC as the natural new technology portable and in-car recorded music medium."

"Our first in-car DCC units will be here early in the new year," he added.

Weighing less than half a kilo, the DCC 130 is made for outdoor action and is claimed to be totally 'jog-proof'.

Compact Yamaha digital mixers

Yamaha Music Australia has announced the new generation DMP9 Series Digital Mixing Processors, compact 3U rack-mounting digital audio mixers in two versions: DMP9-16 and DMP9-8, 16 and eight channels respectively.

The DMP9 mixers provide high quality audio mixing and effects for a wide variety of applications in recording studios, broadcast, film and video post production and MIDI project studios.

All internal processing is performed in the digital domain, with Yamaha's latest digital signal processing (DSP) technology providing professional 16-bit A/D and 18-bit D/A conversion with a dynamic range in excess of 92dB. A 16-character four-line LCD display, and rotary data entry wheel provide easy access to all DMP9 functions, including the dual internal digital effects processor.

The DMP9 features 50 scene memories for storing all mix parameters. Scenes may be instantly recalled, either manually or via MIDI Program Change

messages. All DMP9 functions may be externally controlled via MIDI.

One stereo digital signal in either CD/DAT or Yamaha format may be fed to a pair of input channels or straight to the stereo bus. Digital outputs can be fed from either stereo bus, pre or post fader. A BNC connector is provided for external wordclock synchronisation.

The DMP9 features two internal digital multi-effect processors, providing a wide range of effects including reverbs, delays and modulation effects.

For further information, circle 181 on the reader service card or contact Yamaha Pro Digital Group, 17-33 Market Street, South Melbourne 3205; phone (03) 699 2388, fax 699 2332, or on the Pro Digital InfoLine (008) 80 3049.

21" and 25" CTVs from Akai

Akai have released two new colour TVs, designed to capture a greater share of the crucial 21" and 25" CTV market.

The new models provide UHF/VHF tuning, remote control, FST (flat screen tube) display with full onscreen readout, and both have A/V and RF input facility. The CTK-2166 21" model has a mono tuner, 40-programme memory and twin dynamic speakers.

The larger 59cm (25") CTK-2576 is designed as a quality high-resolution CTV, with stereo tuner, Teletext and A/V, SCART, RF and S-video inputs for today's high resolution camcorders and VCRs. The CTK-2576 will also supply the important 'home theatre' surround sound market that is fast becoming popular. Front panel A/V inputs for quick VCR and camcorder connection are added features.

Priced at $699 (CTK-2166) and $1499 (CTK-2576), both models are covered by a 12-month parts and labour warranty and are available at selected Akai dealers.

New speaker kit from Peerless

Once a widely distributed brand in Australia, Peerless disappeared from the hifi scene for some 10 years, until Australian distributorship was resurrected by Scan Audio. With the introduction of a new range of kit speakers, Peerless is once again set to become a well-known name amongst hifi enthusiasts.

The first kit to be released is the PSK 60/2 speaker system — a 'classic' bookshelf design employing a 175mm bass/midrange driver and a 25mm dome tweeter. The bass/midrange driver uses a polypropylene cone with a low impedance foam surround, finished in a 'Square-line' frame design. The Fb (box tuning frequency) is 45Hz in the 14 litre bass-reflex cabinet.

The dome tweeter used in the Peerless PSK 60/2 features a 25mm voice coil with aluminium former and a woven textile dome.

The complete kit is extremely easy to assemble — all parts are supplied, even down to PVA glue for assembling the wrap-around cabinets. The crossover network comes pre-wired with push-on tags, so no soldering is required. Other parts included in the kit are: damping material, grille studs, the terminal/crossover assembly, screws and comprehensive instructions.

The kit may be purchased with or without the flat-packed cabinet kit. For those who wish to make their own cabinets, full plans are included in the kit.

Rated power handling capacity is 60 watts RMS. Sensitivity of the PSK 60/2 is 88dB (one watt at one metre), while the frequency response is 55-20,000Hz (+/-3dB). Overall impedance is eight ohms.

Price for the hardware kit excluding cabinets is $269/pair with the flat-packed cabinet kit an additional $130/pair. The woofer (DSE Cat. C-2106) is priced at $80 each, and the tweeter (DSE Cat. C-2101) at $50. each

The Peerless PSK 60/2 is available excusively from selected Dick Smith Electronics stores around Australia. ❖

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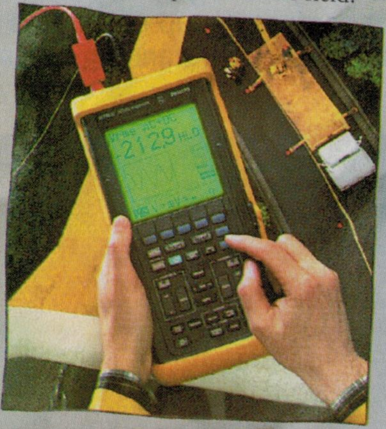

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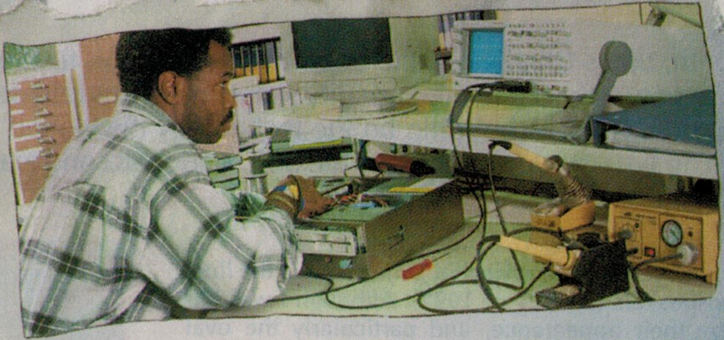

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JAMO'S NEW 507 LOUDSPEAKERS

This month, Louis Challis had the opportunity to run his test instruments and calibrated ears briefly over one of the new 'affordable' high-quality speaker systems released recently by the highly respected Danish manufacturer Jamo — building on the technology developed for that company's top of the line 'Oriel' system. The system reviewed here is the 507, a compact and elegant three-way floor standing system rated to handle 150W.

It is about a year since I reviewed Jamo's 'top of the line' Oriel loudspeakers (*EA* August 1992). Although I was impressed by their appearance, and particularly the oval shape of the cabinet, I believe I was justifiably critical of certain aspects of their performance — if for no other reason than at $17,000 for a pair, one has justification in expecting (if not demanding) perfection.

Loudspeakers with a $17,000 price tag don't move nearly as fast as do those in the $500 to $3000 range, of course. Consequently, it is not all that surprising that Jamo have examined the most desirable features of the Oriels (which I consider to be their oval shape), and refined that concept one stage further in a new and somewhat more affordable range of loudspeakers — where the oval shape was sensibly applied to provide significant advantages in terms of performance and appearance.

The result was the Jamo models 507 and 707 loudspeakers, which are visually more attractive than the Oriels, and with less than 1/5th the price tags are also more attractive in that direction as well. In fact they already developing an impressive niche in the marketplace, I understand.

Jamo's design team realised that women prefer loudspeakers which do not make too bold a statement; i.e., they should not be too big, nor dominate the room. Women appear to exercise 'right of veto' on the appearance related issues in a large proportion of households, and the designers of the Jamo 507s have taken that fact squarely into account.

In that respect alone the Jamo 507s would have to be 'head and shoulders' over many of their competitors, as with a width of only 223mm, relatively few people even notice their depth.

In addition, their height is close to perfect at 915mm — a height that is equally appropriate for putting down your drink, quite apart from providing a place to put ashtrays. Aware of this too, the designers then sensibly provided appropriate protection in the form of a black glass top, which is not only 'attractive', but very sensible, as stains and cigarette burns will no longer be a problem.

The sides of the cabinet are gracefully curved, beautifully veneered, and use a brand new sandwich construction incorporating MDF chipboard with internal longitudinal (vertical) grooves, over which a second similarly shaped board is then glue bonded.

This composite structure is very rigid, anti-resonant, and provides the type of performance characteristics which are perfect for a loudspeaker cabinet. The back and front of the cabinet are made of thick black MDF board, whose dimensions are so small that they are very stiff and similarly tend to be relatively non-resonant.

The inside of the cabinet has a continuous layer of profiled polyester foam, glued over all the internal surfaces, which provides added damping, appropriate sound absorption, and thereby minimises unwanted mid-frequency regenerated noise components which the sub-woofer system might otherwise emit.

The front of the cabinet has two cloth covered panels, the upper of which is profiled with cut-outs to match the loudspeaker immediately behind. This panel is retained in place by means of magnets, and by the tightness of its fit between the extensions of the side panel structure.

Immediately behind the panel are three relatively small, but beautifully designed speakers, the upper and lower of which are mid-range drivers covering the frequency range 150Hz to 1.5kHz, whilst the centrally located tweeter covers the frequency range from 2kHz to 17kHz.

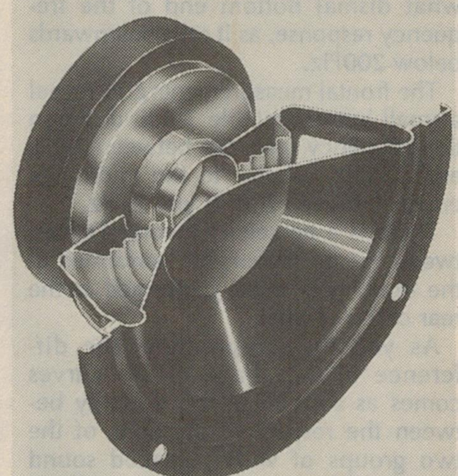
The mid-range drivers are unusually small, with a face dimension of only 90mm, and have a polypropylene diaphragm to which a flexible roll surround is thermally bonded during the manufacturing process. The dust cap at the centre of the speaker diaphragm is constructed as an integral component, so ithat a true linear piston motion is achieved, with excellent results. The 25mm soft dome tweeter is centrally located between the two mid-range drivers, and is cleverly indented between them to save space.

The two mid-range drivers and the tweeter are installed in their own separate internally lined cabinet, leaving the rest of the enclosure available for the sub-woofer section, which covers the 50Hz to 150Hz range. The sub-woofer uses a cleverly designed vented enclosure with a pair of 'push/pull' woofers, using a system originally developed by Wally Barlow at AWA.

The rear output of these 'push/pull' drivers is coupled to a separate sealed enclosure, which provides the bandpass performance characteristics to match the other section of the enclosure.

Left: Visible in this cut-away view is the laminated construction of the curved cabinet sides, plus the way that two woofers are mounted in push-pull fashion in the centre of the rear-ported bass enclosure. The two midrange speakers and tweeter are in a separate volume at upper right.

Below: Another cut-away view, this time showing one of the midrange drivers. Only 90mm in diameter, these have a polypropylene diaphragm with an integral dust cap, and achieve true linear piston motion



A single sub-woofer venting port is located 270mm above the floor, at the rear of the cabinet. That location is a trifle unusual in these circumstances, and its logic is hard to understand, as it could just as easily have been placed on the front face behind a matching grille. The port is beautifully contoured at the outlet, but surprisingly has a relatively sharp edge at its innermost end.

One potential advantage of placing that port at the rear is that it is possible to tune the low frequency response of the loudspeaker system as well as the room response, depending on how far the rear of the system is placed from the rear walls and side walls within the room.

Immediately below the sub-woofer venting port is a recess, in which two pairs of gold plated terminals with matching gold plated links are provided — for separate connection to the low frequency and high frequency sections of the loudspeaker.

These terminals make it possible to bi-amp or bi-wire the system, as well as to adopt a conventional single pair feed to the input terminals, if you don't wish to be fussed by complex wiring and amplifier interconnections.

Objective testing

When it comes to testing a loudspeaker system with a rear venting port, there are some obvious and insidious problems — not the least of which are those associated with frequency response testing using an anechoic room.

When a conventional loudspeaker with the speakers mounted on the front face is tested in an anechoic room, directivity issues are not a problem. However, when a speaker system has one primary driver pointing to the rear of the cabinet (which is precisely how the Jamo 507s are configured), the changed directivity and spatial separation between the rear sub-woofer port and the frontal array of loudspeakers complicates the relevance and objectivity of the conventional measurements performed within the anechoic chamber.

The Jamo 507s have been designed to make use of the reflective characteristics of the rear wall against which they are placed, and measurements

performed in an anechoic chamber have to be reviewed and re-interpreted in the light of that knowledge. There was no simple way around that problem, as you will note from the attached level recordings. Taken from the rear of the speaker cabinets, 1m from the sub-woofer venting port, these reveal dips in the response at 250Hz, 600Hz and 900Hz as a result of spatial phase cancellations. When similar measurements are performed in front of the cabinet, the frequency response directly in front of the tweeter unit displays a somewhat dismal bottom end of the frequency response, as it rolls downwards below 200Hz.

The frontal measurements also reveal a small but acceptable 3-5dB droop in the frequency response between 2kHz and 15kHz, relative to the mid-range energy between 200Hz and 2kHz.

There is a perceived incongruity between the measurements performed at the front, with those performed at the rear of the cabinet.

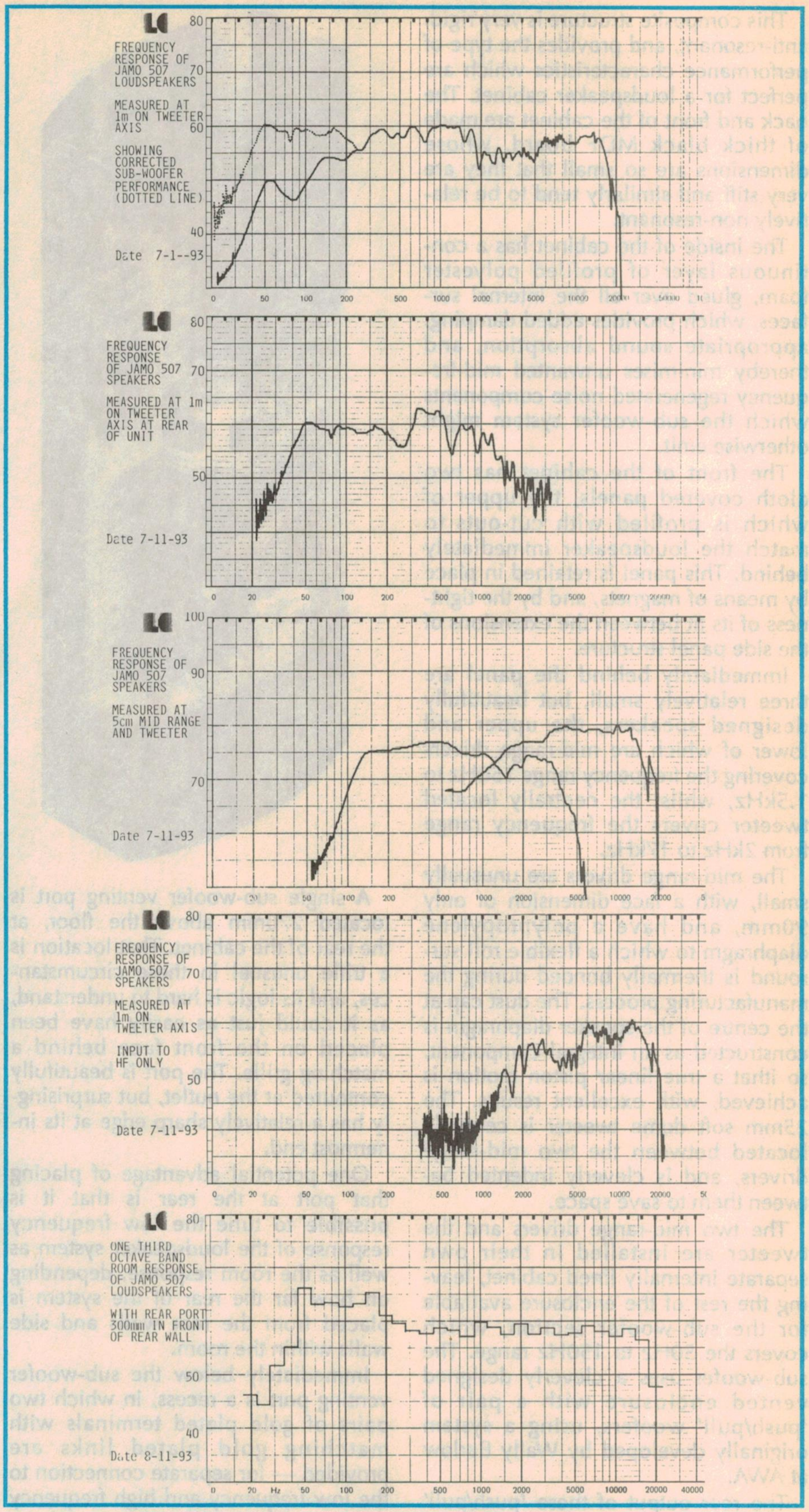
As you may appreciate, the difference in the shape of the curves comes as a result of the disparity between the respective positions of the two groups of widely spaced sound sources. When tested under anechoic conditions, the sound fields cannot duplicate the 'reflected and reverberant' sound summation characteristics of a normal living room.

More critically, the disparity between the two sets of anechoic measurements highlights the need to perform a supplementary set of measurements in order to assess how those speakers will perform in what would be best described as 'real world' conditions. Such measurements were subsequently performed, and are both described as well as being presented below.

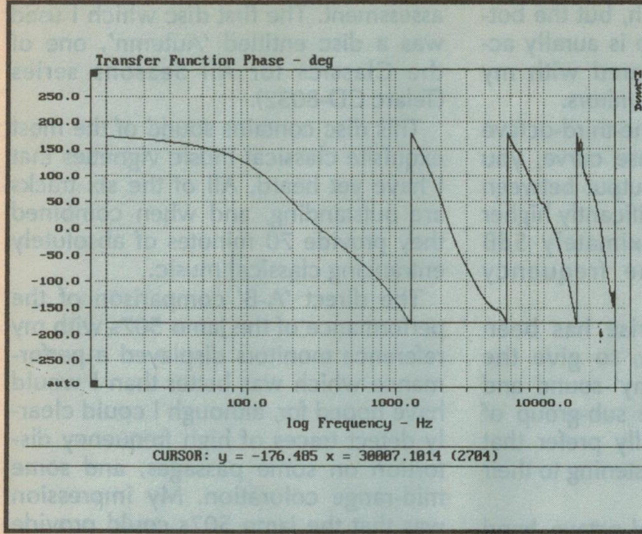
On examining the tweeter response, I noted the presence of an unusual resonance at 17kHz. Although that resonance may not necessarily prove to be audible, it detracts from the otherwise general uniformity of the speaker's overall response, and may well give rise to audible, and thus unwanted intermodulation under specific operating conditions.

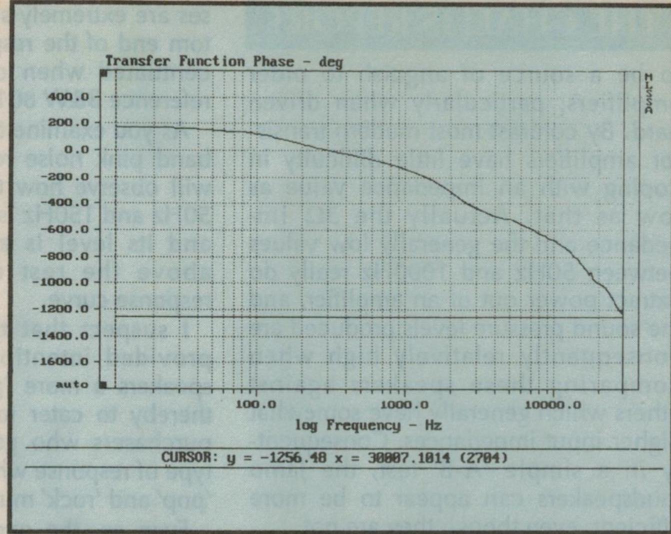
To ensure that this was not just an isolated characteristic of the speaker cabinet that I had selected, I replaced it with the second unit. That test confirmed that the tweeters of both speakers exhibit similar characteristics.

Although the tweeter may be con-



Here are the response curves for the 507 system, as measured in the anechoic chamber. At top is the overall response on the tweeter axis at the front, with the equivalent rear response next. In the centre are the midrange and tweeter responses 50mm from the drivers, and below this the tweeter response at 1m. At the bottom is the 1/3 octave band response using pink noise.





The transfer function phase plots for the Jamo 507. At left is the 'wrapped' presentation, confined to a range of plus/minus 180 degrees, while at right is the 'unwrapped' presentation showing the overall effective phase shift.

sidered as being 'state of the art', I would earnestly recommend that the maker (Peerless of Denmark) devotes a little more care and attention to the mechanical aspects of their design. The tweeter's frequency response would be excellent were it not for the presence of the resonance at 17kHz, and at 13.5kHz.

As it happens, those tweeter resonances constitute my only real criticism of the Jamo 507s. By contrast, the mid-range drivers are particularly smooth, and a similar critical review of the sub-woofer's response confirms that it also provides an equally smooth performance — particularly when one considers the size of the cabinet, and the size of the drivers.

The phase characteristics of the Jamo 507s are also smooth, and as you will note from both the 'wrapped' and 'unwrapped' phase responses, quite commendable. The uniformity of the phase response confirms that the positioning of the sub-woofer port at the rear of the cabinet has not resulted in what might have otherwise been a debacle in terms of its impact on phasing.

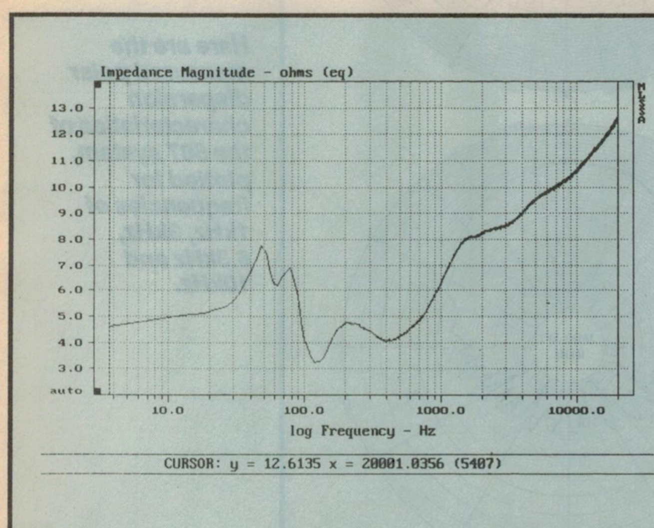
The decay response spectrum, also measured under anechoic conditions, is smooth all the way through to 13.5kHz. At that frequency the tweeter exhibits a measurable and readily detectable decay resonance response.

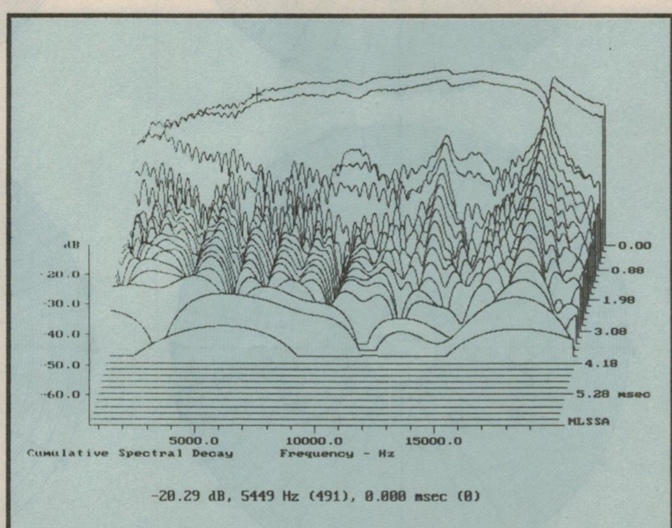
At 17kHz there is a markedly stronger decay resonance, which confirms that once the tweeter is excited at or close to the resonant frequency, it will produce its own characteristic energy, well beyond the time when the initial transient has already dissipated.

Whilst the 17kHz transient is unlikely to be audible except to the relatively younger listeners, by contrast the 13.5kHz transient would be readily audible to most listeners, almost irrespective of age.

The measured input impedance curve of the Jamo 507s displays two relatively low points, of 3.2Ω at 130Hz and a value of 4Ω at 400Hz. Whilst Jamo describe the speakers as being nominally 4Ω, in point of fact they are closer to 3Ω when correctly evaluated on the basis of the International Electro-Technical Commission's relevant directives.

The 3.2Ω impedance may well prove





As you can see from the impedance curve on the left, the Jamo 507 drops down to about 3.2 ohms just above 100Hz, and to approximately four ohms at about 400Hz. On the right is the cumulative spectral decay characteristic.

to be a source of anguish to older amplifiers, particularly when driven hard. By contrast most modern transistor amplifiers have little difficulty in coping with an impedance value as low as that. Actually the 3Ω impedance and the generally low values between 50Hz and 1000Hz really do extract power out of an amplifier, and the sound pressure levels produced are consequently relatively high when comparing these speakers against others which generally have somewhat higher input impedances. Consequently in a simple 'A-B' test, the Jamo loudspeakers can appear to be more efficient, even though they are not.

An examination of the polar plots for the Jamo 507 loudspeakers reveals that the output directivity is remarkably smooth all the way up to 6.3kHz, and it is only at 10kHz where the bandwidth of the arc is reduced to a 50° included angle.

The pink noise assessment of the Jamo 507 loudspeakers reveals that the mid-range and high frequency responses are extremely smooth, but the bottom end of the response is aurally accentuated when compared with my reference B&W 801M monitors.

As you examine the one-third-octave band pink noise response curve, you will observe how the output between 50Hz and 150Hz is significantly higher and its level is approximately 5dB above the rest of the frequency response curve.

I suspect that that rise has been provided intentionally, to give the speakers a more 'punchy' sound and thereby to cater for the sub-group of purchasers who generally prefer that type of response when listening to their 'pop' and 'rock' music.

Even so, the one-third-octave band pink noise response is reasonably good, and confirms that the overall frequency response extends from just below 50Hz to beyond 16kHz.

Listening tests

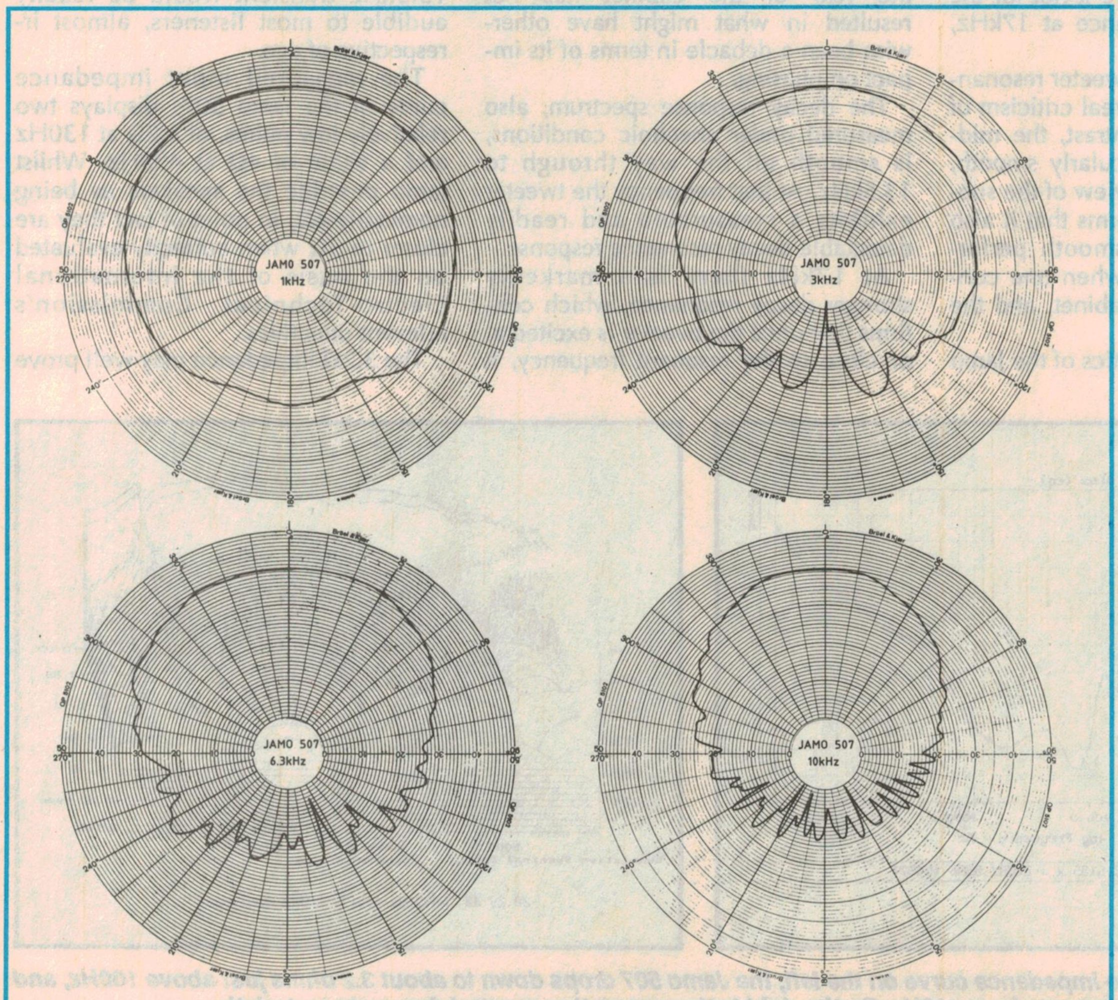
The subjective assessment of the Jamo 507s was generally rewarding, and at times positively exciting. I used a number of new discs for the assessment. The first disc which I used was a disc entitled 'Autumn', one of the Classics for All Seasons series (Telarc CD-8032).

This disc contains sound of the most exquisite classical music vignettes that I have yet heard. All of the six tracks are outstanding, and when combined they provide 70 minutes of absolutely entrancing classical music.

The direct 'A-B' comparison of the performance of the Jamo 507s with my reference monitors displayed a performance which was better than I would have hoped for, although I could clearly detect traces of high frequency distortion on some passages, and some mid-range coloration. My impression was that the Jamo 507s could provide an above-average performance, particularly when you consider the size of the drivers.

The second disc I used in this assessment was John Williams' latest disc, 'The Seville Concert' (Sony Classical SK 53359).

The music on this disc was recorded in the Royal Alcazar Palace in Spain, and it has received considerable



Here are the measured polar dispersion characteristics of the 507 system, plotted for frequencies of 1kHz, 3kHz, 6.3kHz and 10kHz.

Measured performance of Jamo 507 loudspeakers Serial No 052 483 0027				
Frequency response		40Hz - 17kHz +/-6dB		
Crossover frequencies		Nominally 2kHz		
Sensitivity (for 96dB average at 1m)		2.8VRMS = 2.0 watts (nominal into four ohms)		
Harmonic distortion (for level as indicated at 1m)		**90dB* 100Hz**	**96dB 1kHz**	**90dB 6.3kHz**
	2nd	35.2	35.9	41.0
	3rd	40.3	61.3	63.9
	4th	-	-	-
	5th	52.7	-	-
	THD	2.0%	1.6%	0.9%
Input Impedance	125Hz		3.2 ohms	
	250Hz		4.7 ohms	
	1kHz		6.3 ohms	
	4kHz		9.0 ohms	
	8kHz		10.3 ohms	
	Min. at 125Hz		3.2 ohms	

publicity on TV over the last few weeks. I was fortunate enough to attend John Williams' most recent concert at the Sydney Opera House, and must admit that although the disc cannot duplicate the full presence of a live performance, it nonetheless achieves remarkable results. The quality of this recording is superb as it incorporates Sony 20-bit Super Mapping, whose attributes are clearly evident. The frequency response of the music and the staccato demands on the speakers are perfect for the evaluation of the Jamo 507's transient response.

I tend to play my music moderately loud (peak levels in the range 95-105dB) and as a consequence, once again I could detect both significant and subtle differences between the 507s and the reference monitors. The most important difference manifested itself as a harshness at high listening levels, and particularly when the levels exceeded 100dB. At lower listening levels, it was more difficult to detect the differences, although not impossible.

The third disc I used for my assessment was a new Australian Chamber Orchestra recording of Mendelssohn's Octet in E Flat for Strings, Op 20 Sinfonia (String Symphony) and the Ninth String Symphony in C, 'The Swiss', (Sony Masterworks SK 57484).

As I soon discovered, the Jamo 507s revelled in the reproduction of such music, and their performance was almost faultless. The audible differences between the reference speakers and the Jamo 507s were far less pronounced than I might have expected; they were most certainly well up to the task.

The last disc I used was the new Chesky Records 'The Collection', (Chesky PJD 1000). This disc contains Sara K singing 'Wanna Spend More Time', and the differences between the reproductive characteristics of the Jamo 507s and the reference monitors was far more evident, as the human voice provides the non-musician with far more easily interpreted reference material for such comparisons.

Although the Jamo 507s gave a credible performance, they clearly add significant mid-range colouration to the human voice, and at the price at which they sell, that is most probably to be expected.

In summary

Although I only had a limited time in which to carry out my subjective appraisals, I was left with a clear and obvious impression that Jamo have produced an excellent new speaker system — particularly when one considers the critical elements of general appearance, size, and last but not least the quality of their performance when related to their cost.

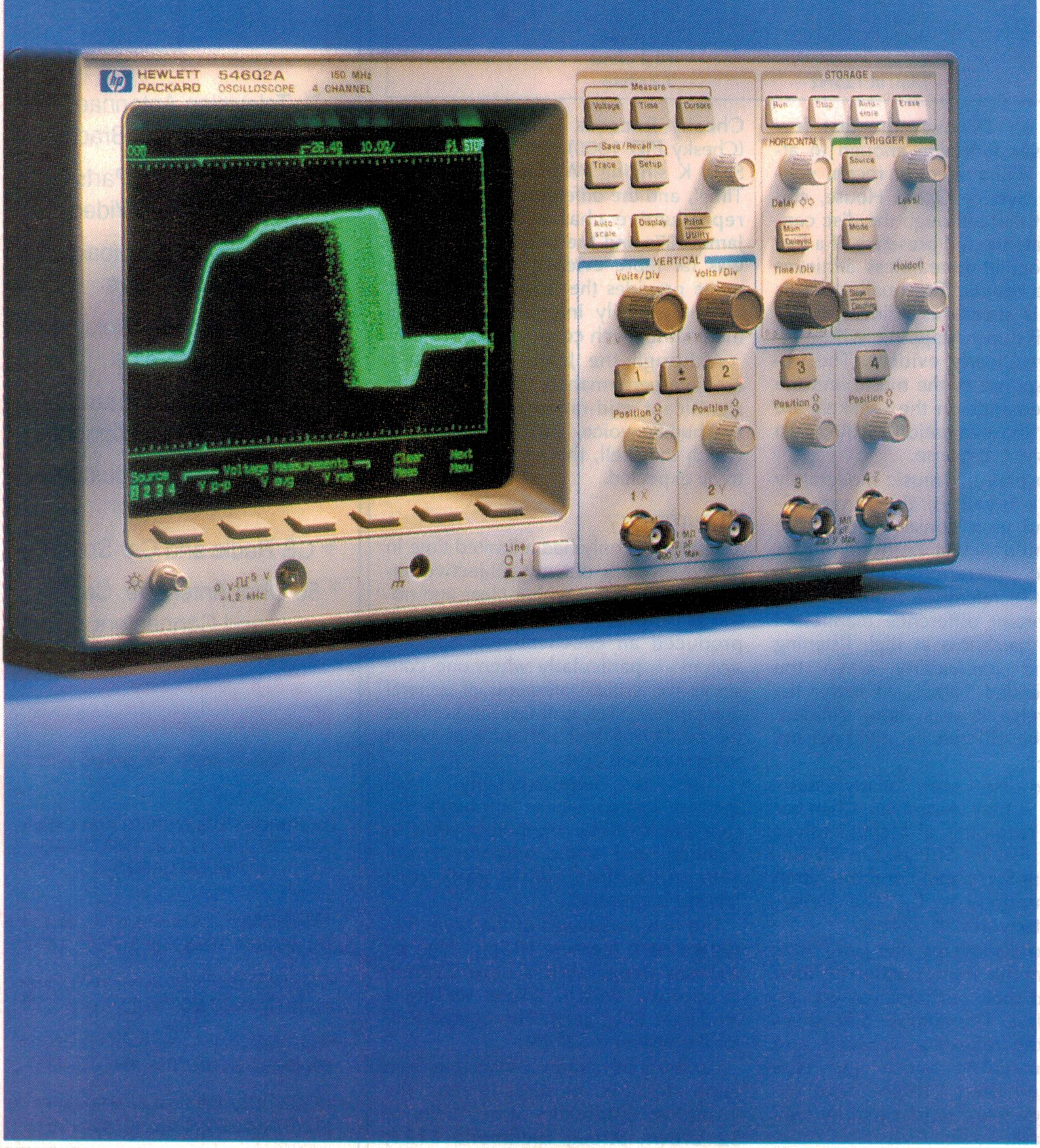
This is unquestionably one speaker system whose attributes ensure that it will be worth your while to audition, and whose appearance will also more than likely gain your 'partner's approval'.

The two enclosures of the Jamo 507 system each measure 915mm high by 365mm deep, with a slim 223mm maximum width. They weigh a moderate 19kg each. The quoted RRP for the system is $2195.

Further information is available from Jamo stockists, or directly from the Australian distributors Scan Audio, of 52 Crown Street, Richmond 3121; phone (03) 429 2199. ❖

Win a

Hewlett – Pack



Tom Moffat gives some first-hand advice on...

REHABILITATING 'ELDERLY' COMPUTERS

What do you do with an ageing XT, AT or similar IBM-compatible PC? They can still be used for a wide variety of day to day computing jobs, even though they may not be as snazzy as the latest all-singing models. But to keep them going, you do need to know how to perform basic maintenance jobs like cleaning card and cable contacts, and also drive heads. Replacing some of the older plug-in cards with smaller modern equivalents can also help to prolong the computer's life — and can often be done for surprisingly low cost.

by TOM MOFFAT

"What you need, Tom, is a new computer." That's what my friendly computer salesman keeps telling me, three years after he sold me my last computer. "Your old computer is obsolete now, it's two generations gone, and you really do need something better". My answer: "Why?"

"Why???", he says, "because a new one will be five times as fast!" I tell him my old one is fast enough.

"A new computer can run WINDOWS!"

"Don't wanna run Windows."

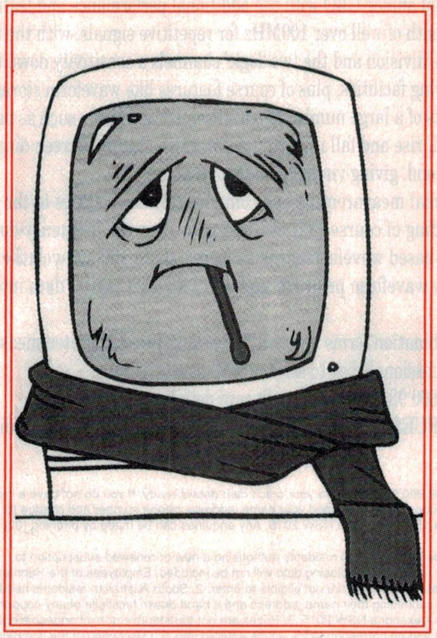
"You'll get four MEGABYTES of memory and you can run all the latest applications!"

"There's nothing wrong with my present applications, thank you very much."

I then tell the salesman that I'm actually there to fix up my old computer — the one he raved on about so much, three years ago: "It's a great machine, Tom, it'll last you forever!". So it's really his *own fault* he's not selling me a new computer; the old one was too good, he's supported it too well, and it's *going* to last me forever. Now I'm only after a new serial card, and his $2500 sale has just degenerated into a $25 sale.

Actually the old computer, an AT model, had been playing up intermittently from time to time. These weren't catastrophic failures, just annoying glitches. Every now and then the computer would lock up or the video would go haywire, requiring use of the RESET button to regain control. On hot days it would also have to be shut down for a cooling off session.

Sound familiar? Well, computers do suffer wear and tear, mostly as a result of ageing and corrosion of the many electrical contacts that bind them together. An old computer can be turned back into a new computer, with a little maintenance and possible replacement of truly 'antique' bits with new stuff that is more modern, and much cheaper than the original.



We're not talking about UPGRADING a computer here. We will be aiming to make an older computer behave exactly as it did when it was new, although it will possibly draw less power and consequently run cooler.

In my opinion, trying to turn an XT into an AT or an AT into a 386 is sheer folly, since all you'll have is an old computer with bigger performance. You can go out and buy a NEW late model machine for less than you paid for your old one — and often for less than it would cost you to upgrade it.

The final straw

After putting up with months of computer deterioration, but being too lazy to do anything about it, the final straw came when I got a new you-beaut fax and data modem. My two previous modems had been of the internal variety, cards that plug into slots within the PC. But the new one is external; it sits next to the PC and connects to it through its serial port.

Initially this seemed to work fine, but I then discovered that the modem sometimes locked up, or failed to initialise properly. After lots of testing, looping data into the modem and back out again, I found that the results became progressively more scrambled as data rates climbed beyond 1200 baud.

I then disconnected the modem, hooked it up to my XT (a REALLY elderly computer), and ran it up through the baud rates. It handled 9600 baud without a hitch, and modem operation was perfect every time. This suggested that the serial card in the AT was faulty, but the problem had not surfaced because I'd never tried to push the serial ports beyond 2400 baud before. So off I went to the computer shop.

I discovered you don't buy just serial cards anymore. What I ended up with was a 'multi-function input/output' card

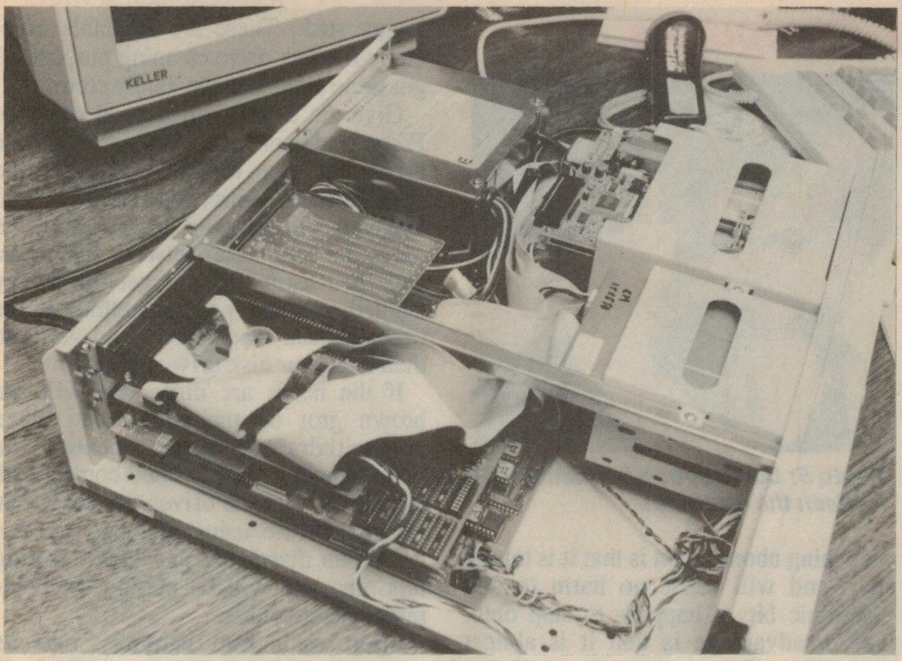


***Photo 1:** The number of contacts is frightening — but not to worry, even if you hook it up the wrong way, the worst thing that will happen is it just won't work.*

— which contained the two serial ports I needed, plus a printer port, plus a joystick port, plus a disk controller for both hard and floppy disk drives. All this on a half sized plug-in card with one big LSI chip in the middle, a few smaller chips, and big flat cables snaking off everywhere. The cost for the whole works: only $25.00.

As I prepared my AT for surgery, I recalled that its existing serial ports were also part of a multi-I/O card, although of far less sophisticated design than the new one. It didn't have the disk controller; that was on yet another plug-in card. So we were about to replace not one, but two, complicated and power-hungry cards with one smaller and simpler card...

Opening it up

But it was time to open the patient.

Photo 1 gives you an idea of what you'll encounter in a fairly average IBM-compatible PC. There are cards and circuits and big flat cables everywhere. Everything you see plugs into something else, and this means lots and lots of sliding contacts. And every one of those contacts is a potential source of trouble.

Remember my comments about the computer locking up; this was almost certainly caused by bodgy contacts, possibly influenced by heating from all that electronics.

So if we're going to whip out two old boards and replace them with one new one, we might as well go whole hog and dismember the entire computer for a total clean-up, mostly of all those contacts.

I know this is scary stuff for the first-timer. What if you get one of those cards in the wrong way around, or put it back in the wrong place? Impossible. First, the cards will only fit the right way around; and second, they will work in ANY card slot (assuming it has the correct number of connections — see later). That's the beauty of the IBM-PC architecture.

What if the new card is the wrong type? What if you plug in one of those cables the wrong way around? Won't it blow up the computer? No. The IBM-PC specification states that everything has to be buffered in such a way that even direct shorts on contact pins will not damage the card or computer.

So if you use the wrong drive card for your disk drives, or if you hook it up wrong, the worst thing that will happen is it just won't work. You can thus tear your computer apart with confidence.

Photo 2 shows my AT in the nude, so to speak. All plug-in cards have been removed. The cables have been flung aside, although at this stage they remain connected to the disk drives on their far ends. The wider one goes to the hard drive, the narrower cable goes to the two floppy drives, and the twisted red and white wires attach to the LED that indicates when the hard drive is in use.

The disk drives have been left installed because they can be attended to in place, and the power supply remains in the far rear corner. You can't do much for the power supply other than to replace it if it goes bung. The computer's 'mother board' is in evidence, held just above the bottom of the case with nylon spacers, and you can see lots of connectors, each with many contacts.

But most of the mother board connectors are NOT used, in this particular computer. It has what is known as a low-profile case; cards can only be mounted horizontally, not vertically as is more common. So they all plug into a

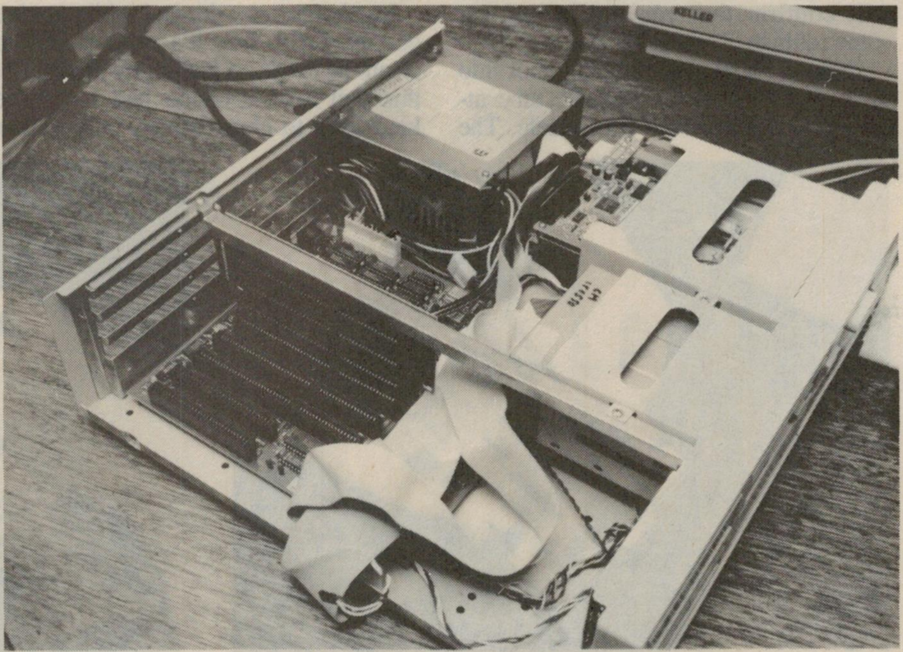


***Photo 2:** All plug-in cards and cables have been removed, leaving the author's AT completely exposed.*

Rehabilitating 'Elderly' Computers

'daughter board', which in turn plugs into one of the mother board slots.

This means every single card in this computer must connect with the mother board by not one, but TWO sets of contacts. (Phooey! This kind of setup spells double trouble. Do not buy a computer with a low profile case, even though it looks pretty.)

Cleaning time

OK, it's time to start cleaning and scrubbing. First go through the case, removing any foreign debris. Tilt the case so anything under the mother board will slide out.

My computer yielded three screws, a dead moth, and the carcass of a large huntsman spider. I wouldn't have any idea where the screws came from; they didn't seem to be missing from anything else. Perhaps they were dropped in while the computer was being assembled at the factory.

For cleaning, Freon-TF is the stuff to use. Do NOT use spray contact cleaner, which can leave an oily film behind. Begin by moistening a linen cloth with Freon and then scrubbing the contacts on the cards themselves. This is being done in Photo 3, to a Trident VGA video card.

Some people recommend cleaning the contacts with a pencil eraser, but this is an abrasive rubber material that would be very hard on the contacts, especially gold-plated ones. Freon is much gentler. Blackening of the cloth will confirm that you did indeed get some rubbish off the contacts.

Photo 4 shows Freon being shot into the contact slots via a plastic tube attached to the pressure can nozzle. The nice thing about Freon is that it is totally inert and will cause no harm to any electronic bits it happens to slop onto. The disadvantage is that it is almost pure chloro-fluorocarbon, the stuff that screws up the atmosphere. But such small quantities are surely insignificant; I've had that same can of Freon for at least five years.

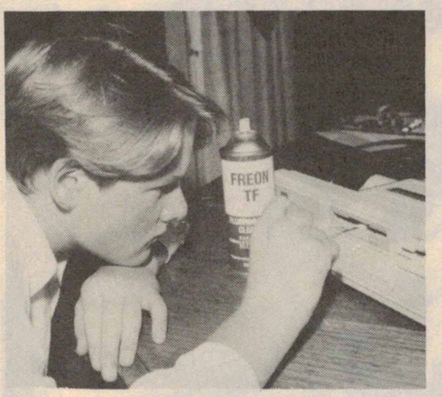


Photo 5: Use a cotton bud and Freon to clean the drive slot.

As each slot is cleaned, it's a good idea to temporarily install its card and wriggle it around a little. This causes metal-to- metal rubbing while it is still 'wetted' with Freon, loosening more corrosion. Then remove the card again and wipe its contacts with Freon once more. Finally squirt some Freon into the contacts on the cables, and wriggle them on and off their connector pins. (Gently, thanks — the pins can bend!) The cards are now ready to be reinstalled.

Just before you do, and while you've got the Freon out, it's a good idea to clean the heads on the floppy drives. For this you need a cotton bud — of the kind used to clean babies, only with a longer stick. These are available especially for disk drive cleaning purposes; I got mine at the nearest Tandy store.

Give the cotton bud a good squirt of Freon and then poke it in through the drive slot. See Photo 5. Feel for the spindle in the centre; somewhere behind that you will find the heads. GENTLY move the cotton bud between the heads, and then away. If you get too heavy handed, you may bend something in the delicate head mechanism, and you can then kiss your disk drive goodbye.

If the heads are dirty, you will see brown grot on the cotton bud when you withdraw it. Keep repeating the process until the cotton bud comes back clean. Then let the drives dry for a few minutes before using them, to prevent the Freon dissolving any disks. During this time you will be putting the computer back together.

Insert each card carefully into its slot and rock it gently until it is firmly seated. DO NOT force it, or you may crack the card, or the mother board, or both. When a card is in place you can attempt to insert the screw that secures it to the computer's frame. It's very likely it will not fit properly since computer cases, and the cards themselves, are not made to very precise dimensions. You can sometimes remove the card's mounting plate and then bend the plate to fit, or you can shim the mounting plate away from the card with washers. Whatever you do, do not force the card. Otherwise it will be under constant mechanical stress and likely to fail at any time. If the screw just won't fit, it's much better to leave it out than to force it.

When reassembling the computer, particularly if using some new cards, it's a good idea to start with the bare mini-

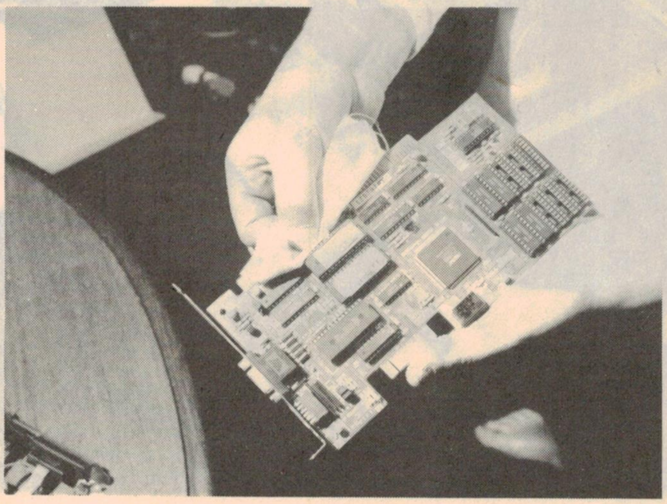


Photo 3: No oily film is left if you moisten a cloth with Freon and scrub the contacts on the cards themselves.

Photo 4: A piece of plastic tubing attached to the nozzle of a can of Freon helps to get at the fiddly bits.

mum configuration and then test it as you go. The bare minimum is a drive controller so the computer can boot up, and a video card so you can see what happens. In our case we have to install the new drive controller as part of the multi-in/out card, so we will have two new serial ports, a printer port, and a joystick port to test all in one go.

Every card module within the computer must be able to communicate with the rest of the system. Data flows to and from the card through one or more in/out addresses, and there is usually an 'interrupt' so the card can signal to the computer that it wants to do something, or that it has just completed its task.

You MUST ensure that every card has its own unique I/O address; otherwise two cards will fight with each other resulting in general havoc. Interrupt numbers can sometimes be shared, as between two printer ports. All this means is that you can't use both printers simultaneously, but who would want to do that anyway?

In my case I wanted the serial ports in the new I/O card to be the traditional COM1 and COM2, but the printer port was to be LPT2, since I use a separate card for LPT1. I have made these arrangements so I can easily reach one port to plug in my Listening Post II and Wesat decoders.

Most cards have jumpers on them so you can select which LPT and COM numbers to assign to which ports. This will be detailed in the card's instructions.

The smoke test

So... with jumpers adjusted and cards plugged in, it's smoke test time. Turn on the big red switch, stand back, and pray. With any luck at all your computer should come up as normal, going through all its power-on testing kerfuffle, eventually to present you with the 'C>' prompt or whatever. But before going any further, you must determine exactly which I/O addresses and interrupts are actually being used so far.

There are several ways to accomplish this. Public domain programs such as SYSID will give you page after page of information, showing you what features are hooked to what addresses and interrupts. A really nice commercial program to do this is called CHECKIT. When the addresses and interrupts are displayed you must take note of them so you can stay clear of them when installing further cards. And be sure to TURN OFF THE POWER before adding or removing cards, or you will learn what computer smoke smells like. In my case the new I/O card worked fine, and I had two cards left to install. The first was the extra printer card, which I set up as LPT1. CHECKIT and SYSID confirmed that it was LPT1, at the correct address, but it insisted on sharing its interrupt with LPT2, despite the fact that an exclusive interrupt was available for LPT1.

I've never been able to figure out why this is so, although I suspect something in the design of the printer card (it's pretty cheap and nasty). The sharing of interrupts has had no effect at all on the operation of the computer.

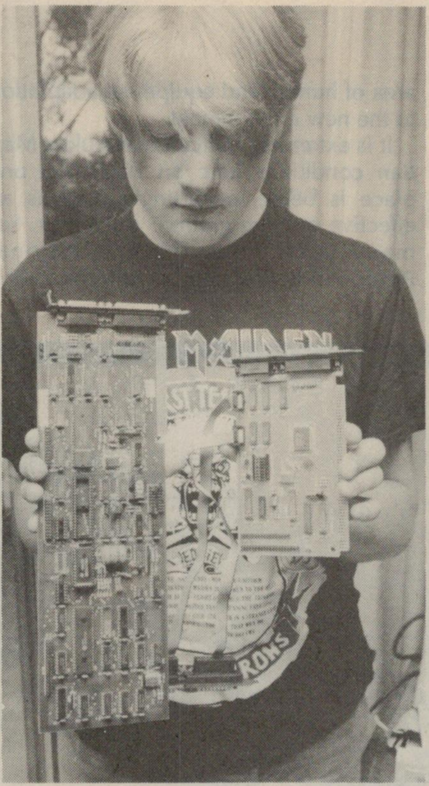


Photo 6: The small card is an up to date version of the large card. Regardless of size, they both perform the same functions.

The final card controlled a hand scanner. A friend sold this gadget to me because it caused too much strife in his big 486 machine.

The scanner card requires DMA (direct memory access), and it has to argue for access rights with things like the hard disk and the video controller. But in my humble AT machine the scanner card worked fine, first try.

Who says I need a new computer? I only bought the scanner because it was cheap, but now I find myself pinching pictures and cartoons from magazines and diverting them to my own purposes. The scanner is lots of fun. I put the cover back on the AT computer, reinstalled it on its table next to my desk, and it's worked fine ever since — just like new. But then I found myself with a multi-I/O card and a disk controller card, surplus to requirements.

Into the old XT?

Then I thought of that ancient XT in my workshop. I had replaced its old Hercules and CGA cards with a more modern single-chip card that handled both graphics modes. But there was still a giant disk controller and multi-I/O card, populated with heaps of 74LS-type IC's, draining the power supply and spewing heat hither and yon. Photo 6 shows this card, held up alongside a modern card that performs the same functions. The only similarities are the connectors on their ends!

I whipped this elderly card out of the XT to replace it with the two newer cards that had been removed from the AT. I did this with some trepidation, because the newer disk controller was for use with two floppies and a hard disk, within an AT computer. The AT plug-in slots actually have two connectors in a row for each card (see Photo 2) while the XT only has the larger connector.

On the AT disk controller card it appeared that most of the lines from the extra slot connector went through some kind of buffer IC and then straight off to the hard drive. Since my XT doesn't have a hard drive, maybe I could just pretend that the whole rear-end of that controller card wasn't there. That sounded ridiculous, but...

Ah, well, it was worth a try, so I installed the disk controller, leaving the extra bank of contacts simply hanging out in space where the second connector wasn't. The floppy drive cable fitted, so I hooked it up and gave it a try. The A: and B: drives both worked perfectly! You beauty! You never know what you can get away with until you suck it and see!

As for the multi-I/O card, and in particular its bodgy serial ports, they worked fine in the XT, allowing the external modem to crank along nicely at 9600 baud. I suspect that I/O card might have been designed for an XT in the first place, and it just couldn't keep up with the higher clock speed of an AT computer.

So now we have an IBM-AT computer that's good as new, and an XT that's better than new. An exercise well worth doing, I think, for a total cost of $25.00 plus an hour or two.

Perhaps I should see about restoring my old CP/M Microbee, now... ❖

DESCENT INTO HELL BY A MODERN DANTE

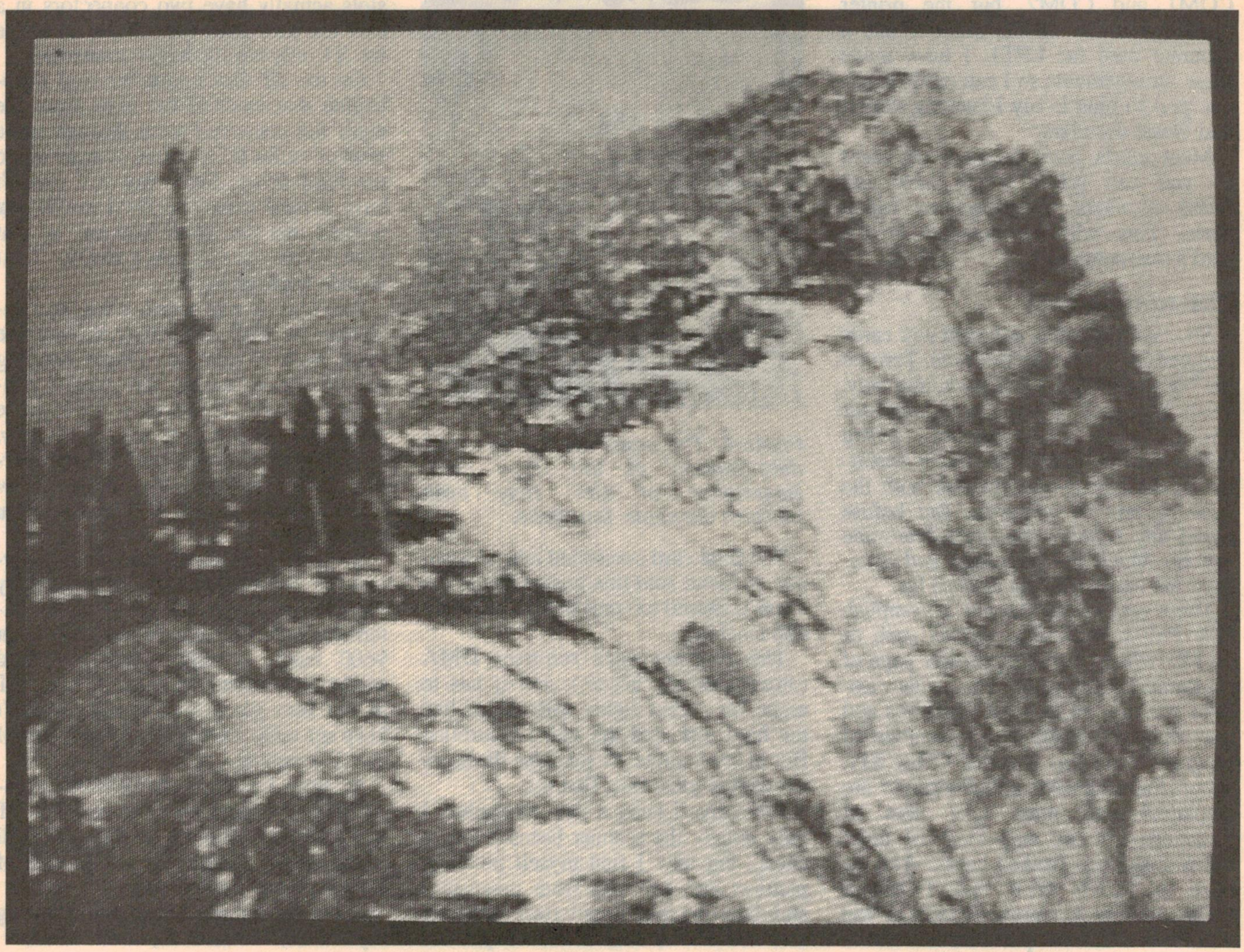
Late last year, you may recall, a team of scientists tried sending an eight-legged walking robot down into the crater of Mount Erebus — Antarctica's live volcano. The experiment struck problems and had to be aborted, but quite a lot was learned nonetheless. It has taken some time for Kate Doolan to find out the details and get hold of some pictures, but here at last is the story behind Dante's aborted descent...

by KATE DOOLAN

Sometime in the next 30 years, people will depart on the long awaited journey to the planet Mars. Depending on the technologies in use, the flight could take anywhere from one to three years. Travelling to and landing on the Martian surface will require a new approach in every aspect of flight, especially in the area of human and equipment adaptation to the new environment.

It is extremely difficult to simulate Martian conditions here on Earth, but one place is being increasingly used as an effective training ground: Antarctica. For many years now, the US National Aeronautics and Space Administration (NASA) have been sending both people and equipment down to Antarctica to gather data on the pressures of surviving and living in a harsh physical environment — which resembles conditions on Mars in terms of climate and isolation.

One recent project of NASA in conjunction with the National Science Foun-



dation (NSF) was Dante, a robot which in December 1992 attempted to descend into Mount Erebus, an active volcano located on Ross Island some 1500 kilometres from the South Pole. Although not a complete success, Dante is paving the way for sophisticated and detailed robotic exploration of the Solar System in years to come.

Dante was christened in honour of the 14th century Italian author Dante Alighieri, who is best known for his play *Divine Comedy*. Part of that play is the famous 'Inferno' in which the author describes his journey to the underworld — where Erebus is a cloud of dust that obscures the entry to Hell.

The twentieth-century namesake of Dante was developed, designed and constructed by the Robotics Institute at the Carnegie Mellon University in Pittsburgh, Pennsylvania.

The US$2 million dollar cost of the program was funded by NASA's Office of Aeronautics and Space Technology. It took only nine months for Dante to go from the drawing board to its journey down inside Mt Erebus.

Eight legs

Dante is an eight-legged robot that weighs in at 400 kilograms. It stands 2.5 metres in height and is three metres in length, with a width of 1.7 metres and a central mast of 2.5 metres. The robot contains 12 electric motors, which can operate various experiments along with its walking motion at the impressive speed of two metres per minute. At the end of Dante's legs are feet which are equipped with proximity sensors to enable the robot to remain upright.

Dante's legs are organised into two groups of four, with an inner and outer frame coupled with a drivetrain which provides the robot with a unique walking motion. To walk, four legs simultaneously lift and reach forward whilst the other four legs propel the body. Each leg can be individually adjusted in height to avoid obstacles.

The two leg frames are rotated with respect to each other, to change the robot's direction. On the steep slopes that Dante was to encounter, a tether system provided a reaction force to gravity and also assisted in maintaining equilibrium — allowing the robot to rappel like a mountain climber. In addition to providing Dante with support, the tether delivered power through six conductors in its inner weave.

Communications with Dante were through a single fibre-optic line, over which seven video, one Ethernet and two serial data communications links were multiplexed. For future missions, radio telemetry may be possible but for the initial trial, the use of a tether was dictated by the steep slopes of Mt Erebus.

This photo shows the Dante robot making a test climb up a slag pile at Carnegie Mellon University, Pittsburgh, PA, in preparation for its Antarctic expedition. Our rather dramatic lead photograph is a screen shot showing the Dante robot in place on the rim of the crater ready for its descent into the Mount Erebus volcano.

The technical objectives of Dante were to demonstrate an exploration mission, environmental survival and self-sustained performance in the harsh Antarctica climate. By working there, it is hoped that scientists will learn what is necessary in a robot whose mission is extended exploration of the Solar System.

Although only a prototype, Dante was not a laboratory-only device. Its components were designed to withstand both the conditions of Antarctica as well as being inside Mt Erebus.

To protect the robot, its metallic surfaces had been anodised to harden them and the computers were rated to stand both extreme cold and heat. Dante was also equipped with sensors that could sense its environment and also 'proprioceptive' sensors to sense its own

Descent into Hell by a modern Dante

status. The on-board computing system provided the robot with basic capabilities for motion. Dante also had sufficient sensing in its feet alone to allow it to feel the terrain and adjust its motions accordingly.

Using a task communications package named TCX, Dante had an integrated software system that enabled project participants to observe, instruct and modify it as the project progressed.

Processes used included perception, planning and control on real-time boards communicating point-to-point via messages. TCX abstracted the coding, transmissions and decoding of messages, making inter-process communications look like function calls. TCX also greatly reduced the time required to integrate a software package and allowed for the addition of new modules when required.

To communicate with the Goddard Space Flight Centre (GSFC) in Greenbelt, Maryland and also the Carnegie Mellon University back in the United States, NASA on a daily basis provided five 20-minute live video links to the Dante team in Antarctica, via feeds from its Tracking and Data Relay Satellite-West (see *EA* June 1993).

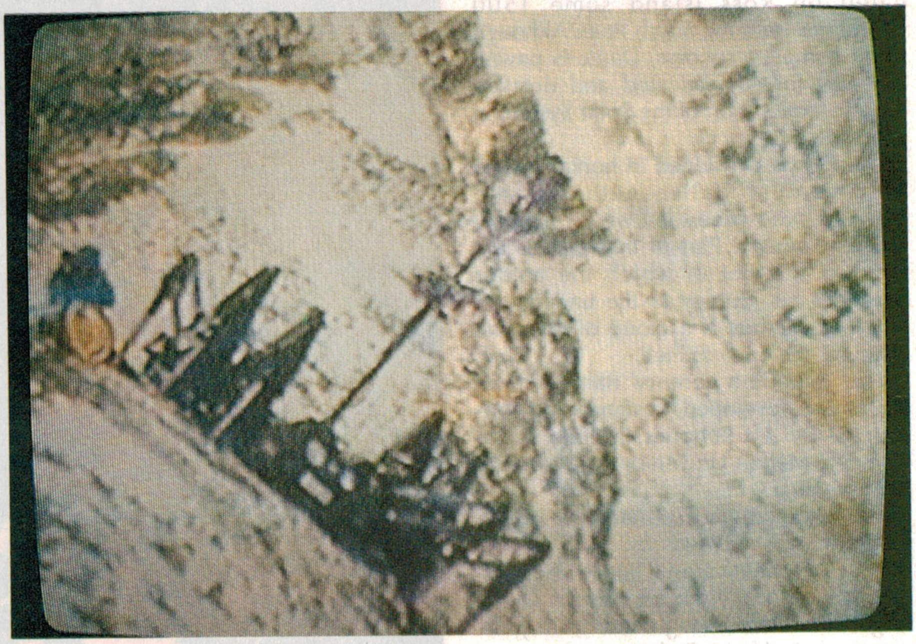
A TDRS S-band transportable uplink system was placed at the foot of Mt Erebus for this purpose, and GSFC provided several TDRS specialists for technical communications support. Five Carnegie Mellon staff members were stationed at the Goddard Payload Operations Control Centre, to provide on-line computer support and if required, robotic and engineering support.

Three video cameras

The Dante project was equipped with three video cameras. Mounted on Dante itself was a colour CCD (charge-coupled device) camera which could look either forward or rearward.

Another similar camera was mounted on Dante's carrier, which remained at the rim of Mt Erebus, while one of the team members had a hand-held video camera for either live action footage or for recording material to be played back at a later date. The quality of the video footage was comparable to that of home video system recordings in terms of colour and resolution.

The frame rate of the TDRS digital video transmission was only six frames per second, which is one fifth the required speed to create effective and smooth full-motion video. So the footage had a moderately jerky appearance, similar to the quality of television transmissions from the space shuttle. It was not technically feasible to provide live audio with the transmissions, but this problem is being worked on for future projects.



The information about this photo was rather confusing, but we believe it shows Dante descending into the crater of the Mount Erebus volcano.

Dante was fitted with a 'trinocular stereo' rig which used a new 'sum of sum of squared differences' algorithm, capable of generating depth maps of visible terrain. In addition, a scanning laser rangefinder sensed terrain depth in a 360° circle around the robot. Depth information from sensors was used to generate an accurate model of the terrain.

The stereo system used has a large range and high resolution, but is susceptible to a lack of texture and the resolution comes at the expense of processing time. In contrast the laser system has high accuracy with a scan acquisition of three to five seconds, but it is delicate and sensitive to variations within the terrain.

Dante's software system reflected the basic 'sense, plan and act' cycle that enabled the robot to walk and operate autonomously. The terrain mapper transformed depth maps in the co-ordinate system of a particular sensor into a common elevation map.

An operator gave Dante instructions to walk, roll, yaw and lift the robot. These instructions were in the form of the trajectories that were to be followed. The operating system then took those trajectories and broke them down, working out all of the body motions required to follow the trajectory.

That meant if Dante was operating autonomously, the body motion was adjusted to avoid colliding with the terrain. Next, the basic leg motions required to propel the body along the trajectory were generated and by sensing the terrain, all the leg motions were adjusted to avoid contacting the terrain during the stepping phase — while at the same time ensuring correct contact with the terrain during the support phase. This process is known as 'gait generation', and results in a detailed plan to make Dante walk along the commanded trajectory.

The Dante control system is a real-time process that runs onboard the robot. It co-ordinates the actuators and reads status from encoders and other sensors. A graphic simulator was developed to act as a 'virtual robot'. Its message interface is identical to that of the actual controller so plans generated by the gait planner can be simulated to observe the outcome.

A user interface display periodically polls the controller for status information about Dante. It displays a three-dimensional kinematic view of the robot, with readouts of all actuators and sensors.

Slag heap testing

Before leaving for Antarctica, the Carnegie Mellon robotics staff used a 'slag heap' to test the responses of Dante walking over rough ground. Tests were performed in a fully autonomous walking mode, using perception in a rolling terrain. A number of tele-operated tests evaluated the robot walking under ten-

sion control, ascending and descending hillsides. Materials used on the slag heap included rock, gravel, sand and loose blocks. After these tests, Dante was given a 'clean bill of health' to operate in all environments.

A frozen inferno

In early December 1992, Dante and its team of researchers were flown down to McMurdo Station by the United States Air Force. On arrival, the team spent several days adjusting to the environment before being sent to an altitude acclimatisation site to get used to heights and the weather. Following that, the team were then flown to Mt Erebus by helicopter where they set up a base camp.

Snowmobiles were then used to haul Dante and its supplies up to the outer slope of the mountain. Then both people and equipment were shifted to the summit by foot.

Mt Erebus is the only active volcano in Antarctica. It rises from the Ross Ice Shelf on the east coast and stands 3794 metres tall. On Erebus, the summer temperature is a cool -20°C. The summit of the mountain opens into a main crater 150 metres in depth and holds one of the few magma lakes — which are a rare example of volcanic equilibrium, in which the volcano maintains steady activity but it does not violently erupt. Fresh hot magma rises to the surface as cooler magma sinks down.

The scientific goals of the Dante project were to determine the composition of gas generated by Erebus and to measure the temperature of the magma lake. Insights into the composition and nature of the magma within the Earth's crust are possible by studying the lake inside Erebus. By identifying the composition of the gases released from the lake and nearby vents, the effects of volcanoes on the atmosphere can be better understood.

Dante carried five scientific experiments, one of which was to collect samples into a set of collection bottles. Gas would have been pumped into the bottles through a 2°-of-freedom titanium sampling probe, which if close enough, could have drawn gas directly from the magma lake.

Also linked to the robot were a set of filters which could have been used to sample fine particles suspended within the volcano. At various times during the exploration of the crater, filter samples would have been taken.

A Gamma Ray Spectrometer (GRS) was also included in the science package. The GRS measures the radioactivity of materials, and by recording the gamma ray spectrum of material was designed to collect data about the increasingly younger lava as Dante descended into the crater.

If Dante had reached the crater floor, the GRS would have been used to analyse sublimates that drop out of gases as they exit the crater and hit the cold air. The GRS is similar to the same instrument on board the Mars Observer spacecraft, which arrived at Mars in August 1993 and then lost contact.

The last experiment on Dante was an infrared thermocouple, a device which measures the temperature of bodies from a distance by measuring the infrared radiation that they produce. The infrared thermocouple would have been trained on the magma lake whenever possible, in the hope of observing large gas bubbles breaking the surface of the lake and revealing the liquid magma underneath.

On the day...

There was a day's delay to the start of Dante's descent, caused by a minor eruption at the rim of the volcano. No damage was done to the robot, but clouds of gas would have made it difficult to see. It was expected that Dante would take between 24 and 36 hours to make the 280-metre descent to the crater floor. After a short stay, the plan was that it would rappel itself back up the crater wall where it would be recovered.

However all of these plans were abandoned, when Dante broke a fibre-optic cable after travelling six and a half metres. The robot had two spools at its rear, which play out the optical cable linking Dante's onboard sensors and motors with its brain — the computers that provide its depth perception and ability to self navigate. The first spool successfully laid down cable from the team's control centre to the crater rim.

The second spool, which resembles a ball of string, was to release cable during Dante's descent. That cable proved to have a kink in it every five metres, and it was one of these kinks that snapped and brought the mission to its premature end. The team did not anticipate this happening, and did not have a spare cable readily available.

It was decided to end the mission, as it was not known how long it would take to get a replacement cable.

With the short Antarctica summer, it was expected that the Dante team would have another *really* 'white Christmas' before sending their charge on another descent into hell...

In closing, the author would like to thank Jim Elliott of the Goddard Space Flight Centre for his assistance in the completion of this article. The photographs used are courtesy of Goddard Space Flight Centre. ❖

70 years of radio broadcasting in Australia - 2:

SYDNEY'S SEALED SET STATIONS - 2FC AND 2BL

In this second and final article commemorating the somewhat shaky start of radio broadcasting in Australia, the author looks in particular at Sydney's first two stations. Both 2FC and 2BL began operation as commercial stations, even though they were later to become part of the ABC when it was formed.

BY COLIN MACKINNON, VK2DYM

In August 1923, the Australian Government released its Broadcasting Regulations, which permitted public broadcasting under the infamous 'Sealed Set' scheme. The regulations provided initially for two broadcast stations each in Sydney and Melbourne and one in WA, which would be permitted to charge listeners for their programmes. The broadcast was to be received on a wireless set tuned to the listener's choice of station, and then 'sealed' so that it could not pick up the rival station. The broadcasters were known as 'sealed set stations'.

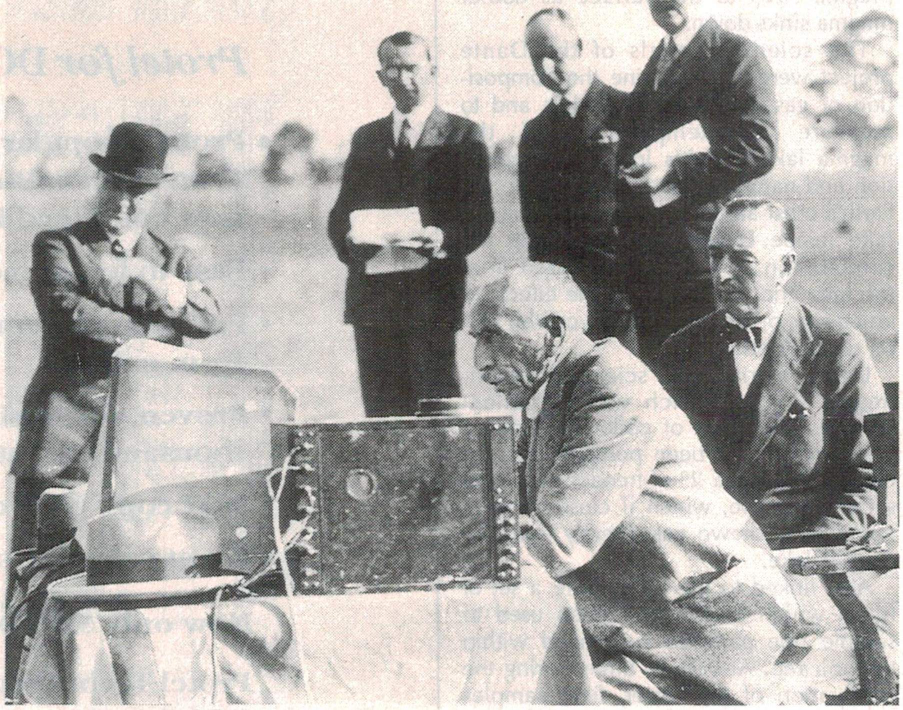
The retail store Farmers Ltd, along with the proprietors of *The Evening News*, the *Sydney Morning Herald* (John Fairfax Ltd), J.C. Williamson Theatres, J. and N. Tait (entertainment promoters) and Dalgety Ltd (stock and station agents) banded together to form Farmer and Company, with a share capital of £16,000, and applied for a broadcast licence (No.1) with the call sign 2FC.

Interestingly Sir George Tallis, a joint Managing Director of J.C. Williamson, had been a founder of the Australasian Wireless Company way back in 1910. Australasian Wireless Company had built the Telefunken stations at Pennant Hills and Applecross (WA), and two stations in New Zealand in 1912.

At the same time as 2FC was taking shape, another group of investors headed by William John Maclardy, editor of *Smith's Weekly* and the *Daily Guardian*, formed Broadcasters (Sydney) Limited (BSL) and received the call sign 2SB (for Sydney Broadcasters). Incidentally, Robert Clyde Packer was the publisher for Smith's Newspapers. Maclardy was a keen wireless experimenter, call sign 2HP, and had established the first magazine devoted to wireless experimenters and listeners: *Electronics Australia*'s ancestor *Wireless Weekly* (first issue August 4, 1922).

Other shareholders in BSL included: Continental Radio Co, L.P.R. Bean, Colville Moore, Wireless Supplies, United Distributors, Radio Co, Radio House, Universal Electric, O'Brien & Nicoll, Pitt Vickery Ltd, F. O'Sullivan, Electricity House and N.P. Olsen (of Newcastle). They were all wireless retailers, who paid a weekly subscription of 5/- each towards the running costs of the station and expected to make their profits by selling receivers tuned to 2SB. BSL was formed in August 1923 with capital of only £113.

Sir Joynton Smith, the Chairman of Smith's Newspapers, became the Chairman of Broadcasters, while Maclardy be-



W.M. Hughes performing the official opening of the 2FC transmitter at its radio centre in Pennant Hills, on March 29, 1926. Seated behind Mr Hughes on the right is George Wright, managing director of Farmer & Company, while standing at the rear are (left to right), Sir Frederick Stewart, Oswald Anderson, Andrew MacCann and A.S. Cochrane.

This photograph was taken in the main Market Street studio of 2FC, on May 23, 1928. The occasion was the departure of Raymond Ellis, and what was described as a group of '100 artists' had gathered before the microphone (front right) to sing 'Auld Lang Syne'. Only about half of this number seem to be present for this photo... (Courtesy AWA).

came the Managing Director. Cecil Vincent Stevenson, proprietor of Electrical Utilities and Radio House, was another BSL shareholder and took on the Treasurer's position. In late 1924 he sold his BSL shares to Sir Samuel Horden (of retailer Anthony Hordens), so that he could start his own station — originally called 2EU, for Electrical Utilities, but which was quickly changed to 2UE for better phonetics.

Whereas 2FC charged listeners a fee of £3/3/- for the privilege of listening to it, 2SB announced that it would only charge 10/- — to be passed on to AWA as a royalty payment — and its broadcast service was free. In both cases listeners also had to pay a licence fee of 10/- to the PMG.

Both companies arranged for receivers to be built and pre-tuned to their respective wavelengths, and these were sold by authorised retailers, together with the licences.

2FC contracted with AWA for the supply of a complete 5kW transmitting station and the running of its station, and paid a very hefty royalty fee to AWA. It is understood that the cost was around £11,000 plus 25% of all revenue.

2FC commenced a trial of free broadcasting on 350 metres (857kHz) on 15/11/1923, using a low powered transmitter supplied by AWA and situated on top of the Farmers building, but its two 62-metre high aerial masts were not erected at the transmitter site at Willoughby (now Castlecrag) until 27/11/23. 2FC started full time operation on 5/12/1923 and was officially opened on 10/1/1924, using studios situated in the Farmer's store at the corner of Pitt and Market Streets, on a frequency of 1100 metres (273kHz).

2SB's transmitter

2SB refused to concede to demands by AWA to buy its equipment and pay royalties, and proceeded to build its own transmitter. In the meantime, Maclardy arranged for a 10 watt transmitter to be installed in an office of the Smith's Newspaper building in Phillip Street, with the aerial strung between two masts on the roof.

The transmitter included two oscillator and two modulator valves, using Radiotron 4.5-watt valves and was owned by Ray Allsop, 2YG, who was building the high power transmitter.

Broadcasters Sydney Ltd commenced limited operation on 23/10/23, using Maclardy's call sign 2HP. 2HP was on the air nightly on behalf of BSL from 7/11/23, and then the large transmitter commenced operation on the night of Friday 23/11/1923 with a concert starting at 8pm. The Saturday program ran from 10am to 10pm, but normally 2SB was only on air 6 to 10 hours per day.

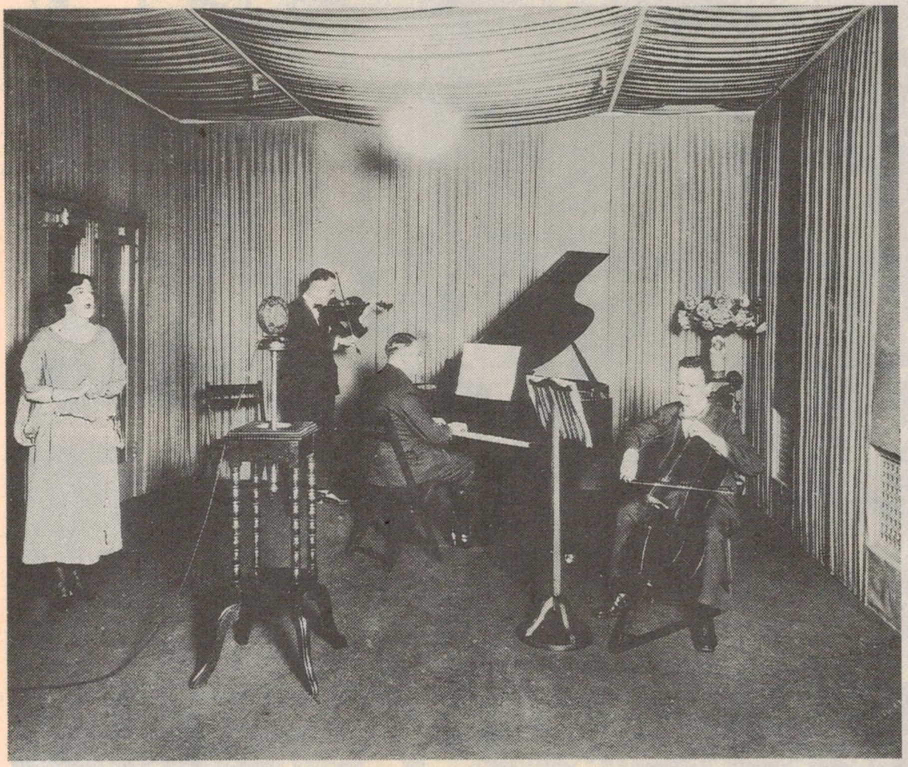
The official opening of the station was advertised and should have been on 15/11/23 (and it is often quoted as commencing on that date), but the PMG caused some delay because it was not ready to test and authorise sealed receivers until the end of November. 2SB was finally inaugurated on Thursday 13/12/23 when the Postmaster General, Mr W.G. Gibson officiated. 2SB transmitted on a frequency of 350 metres.

A typical early program consisted of: Commencing at noon - Sporting news, fish, fruit and vegetable market reports from the Alexandria produce markets, morning stock exchange reports.

1.00pm - orchestral and music programs.

2.00pm - weather, noon stock exhange reports.

Sydney's sealed set stations - 2FC and 2BL



One of the earliest known photos of an Australian radio broadcast, it was taken in 2FC's studio in 1924. The only performer identified is pianist Horace Keats.

3.30pm - chats to women.
3.45pm - orchestral selections.
4.45pm - Sussex Street markets report.
6.30pm - final stock exchange report.
6.45pm - bedtime stories.
7.30pm - orchestral selections.
8.00pm - concert or dance music.
10.00pm - God Save the King (close).

Music and singing was either live from the studio or from records. Monday and Thursday were radio dance nights, when a live orchestra played suitable dance music for a couple of hours. The program was broadcast to a number of city theatres, such as the Tivoli, Kings Cross Theatre, Fuller's Vaudeville, the Real Estate Institute Hall, and the Poster King stand at Coogee.

Obviously the theatres attracted dance patrons and interested listeners to their nightly performances, but you are probably wondering what the Poster King offered? He had an eight-valve receiver with a large Magnavox speaker and horn, which carried the sound more than 250 yards and drew listeners like flies to his stand on the beach, selling pictures and posters.

Noisy reception

Reception reports of 2SB came from as far away as Tasmania, but the average Sydney listener had to suffer RF noise from DC generators common in the city and poor performing receivers.

Although 2SB started with little capital, the shareholders subscriptions were expected to maintain the operation. However the 'sealed set' system was a total failure and people refused to buy wireless sets which could only receive one station. The retailers were not making any money and were reluctant to pay their 5/- weekly subscription. In one case BSL took J.S. Marks of Electricity House to court, over non-payment of £73/2/6 in subscriptions.

Fortunately for 2SB, the retailers Anthony Hordens and David Jones provided substantial financial assistance to the station in order to match the exposure gained via 2FC by Farmers, their retail competitor.

Charles Lloyd Jones, the chairman of David Jones, was very interested in wireless and determined to invest in broadcasting, and formed a company, Associated Interests, in which DJ's, Anthony Hordens and Smith's Newspapers each held a share. Associated Interests was essentially the guarantor for bank loans to keep 2SB solvent.

The *Sun* newspaper, a rival of 2FC's supporter the *Evening News*, took up £7500 worth of debentures in 2SB which was later converted into shares. The proprietor of the Sun Newspaper group was Sir Hugh Dennison, who was another founder of the Australasian Wireless Company in 1910, and became the Chairman of AWA when that company was formed in 1913.

Broadcasters Ltd spent over £9000 on equipment and studios, but even with support from the retailers it was still losing £5000 per year.

David Jones, like other retailers, had a 'wireless retail section' to take advantage of the public clamour for wireless sets. The David Jones Radio Department was a separate store in Pitt Street managed for a time by F. Basil Cooke, son of the NSW Government Astronomer and a well known wireless experimenter with the call sign 2LI. (I have never found out what the F. stood for.) Cooke had been the second licensed experimenter in Western Australia, and had held the 1914 callsign XADW.

Cooke also designed receivers, and had them made with the DJ brandname in DJ's own workshop, managed by R.C. Marsden, 2JM. Cooke gave wireless talks in the shop at lunch time, to the large crowds of people who thronged to learn about this new phenomenon. DJ's employed a number of technicians and had a fleet of vans selling, delivering and repairing wireless sets. Even though few people purchased wireless sets in the sealed set era, and they were very expensive, there must have been enough business to justify opening the shops. Of course from mid-1924, when 'open' sets came in, all the retailers did very well.

A little known fact is that in early 1924 David Jones set up its own broadcast station, 2DJ, and transmitted musical selections from its wireless shop in Pitt St. The station was under the control of Cooke, who retained the licence for several years after DJ's ceased transmissions in mid-1924.

In March 1924, 2SB's call sign was changed to 2BL, because 2SB was too easily mistaken for 2FC, in spoken and broadcast form.

Scheme was doomed

The sealed set scheme of AWA was doomed from the start, and in mid-1924 a new broadcasting system was devised by a group of interested parties and the PMG. It provided for freely tuneable receivers and a listener's licence fee of between 35/- and 25/-, depending on distance from the stations, to be split between the A class broadcasting stations. These fees were reduced in later years.

The broadcast stations were classified 'A' or 'B', and received a licence for a five year term. The A class stations split

the listener's fee in proportion to size, but could only advertise a maximum of one hour in each 12 hours of broadcasting, whilst the B class stations were expected to obtain their revenue from advertising, etc. In NSW the fee structure was 5/- to the PMG to run the system, 21/- to 2FC and 9/- for 2BL; i.e., a 70/30 split.

This new scheme commenced in July 1924 and was popular with listeners, so that whereas under the 'sealed set' scheme there had been only 1200 licences issued, by June 1925 there were 64,000 on issue. Even so, it was estimated that three to four times as many listeners risked a fine for not taking out a licence.

2BL's transmitting licence was re-issued on 21/7/1924 for a five year term and it did a little better under the new payment arrangements. But it still lost money, despite Charles Lloyd Jones putting substantial capital into the company on behalf of David Jones Ltd (somewhere around £2000 per year), plus guaranteeing loans for another £10,000 in early 1924.

Smith's Newspapers were now owned by Associated Press and were part of the Fairfax empire, and Fairfax also contributed substantial financial aid to Broadcasters. Through the joint company Associated Interests, David Jones and Associated Press became majority shareholders in Broadcasters and 2BL. It seems that David Jones held at least 65% of the shares in Broadcasters Ltd by early 1928.

Although 2BL received 9/- from each licence fee, the Australian Performing Rights Association, representing musical artists, demanded 10% of that as copyright fees, and AWA wanted 5/- per licence! The restrictions on advertising by A class stations meant they made little money from that source, and in fact the A class stations dropped all advertising in early 1927.

Late in 1924, Broadcasters recognised that its studio and aerial location in the middle of the city was not very effective, and commenced a new installation at Coogee.

In early 1925 it relented under pressure from AWA and signed a royalty agreement, and purchased a 500-watt transmitter from AWA for £2380.

Ray Allsop and his engineer E. Joseph converted it to 1500 watts output and installed it at Coogee, as a temporary measure while his company built a 5000 watt transmitter, at a cost of only £3000.

Court rebukes AWA

In 1925 AWA, which had not enforced its royalty demands over valves for receivers, took David Jones to court as a test case — and lost. The court held that the Australian patents had to be taken out by the original inventor — e.g., Marconi, RCA, etc., — not by AWA, which was only the assignee and therefore had no right to demand payment. In addition many of the patents that AWA claimed fees on had lapsed, years ago! AWA was severely criticised by the court.

A little sidelight illustrates how AWA operated. Broadcasters Ltd imported valves directly from RCA in the USA, for receivers that it was having made, because AWA added patent fees (on top of those already charged by RCA) and an exorbitant profit margin.

At one time in 1925 AWA was very short of valve stocks and arranged to buy some from Broadcasters. However, after receiving the goods, AWA deducted the royalty fees it would have received if the valves had come via AWA and refused to pay Broadcasters the full amount!

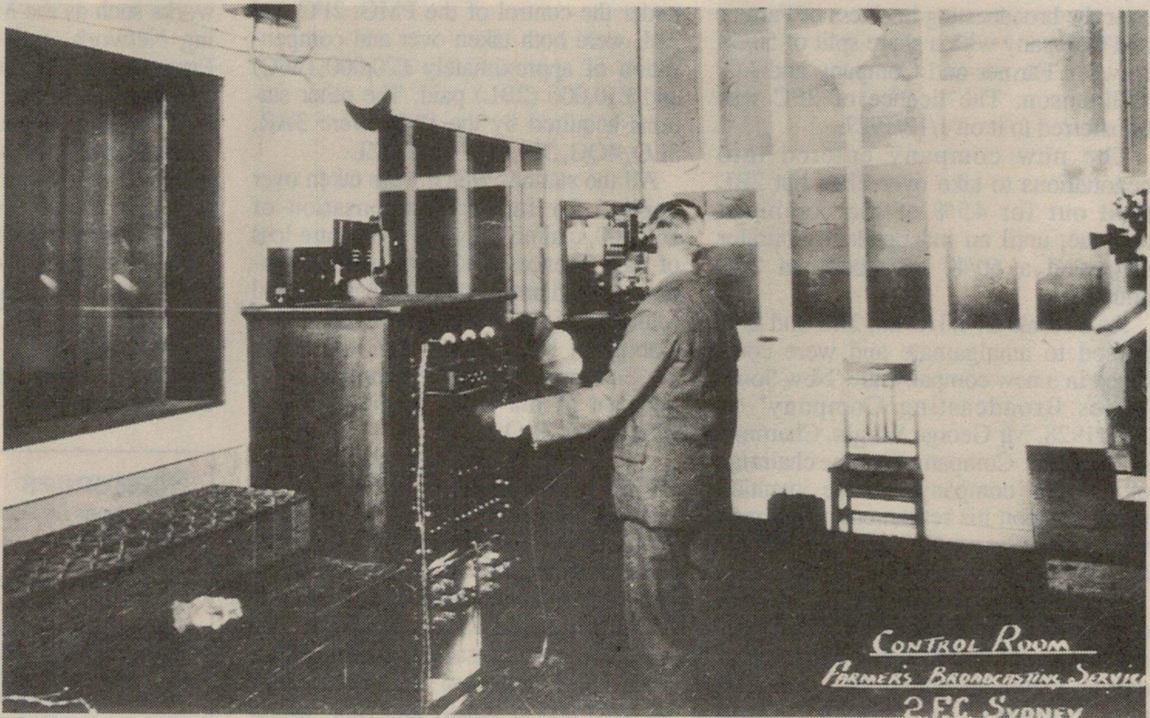
Little wonder Fisk was called a 'bushranger' and AWA was 'the most disliked company in Australia'. Fisk was entitled to protect the rights of Marconi, RCA and the other patent holders, but he seemed to have had about as much sensitivity as Jack the Ripper.

As a result of this court case Charles Lloyd Jones was instrumental in getting the retailers to combine in a group called 'Radio Interests', to fight for their rights against various companies demanding payments.

In the meantime 2FC's licence was re-issued on 16/7/1924 and Farmer and Company was doing much better, with more of the licence fee revenue but also due to the efforts of its backers in promoting and combining services such as the news and entertainment.

Artists appearing in the J.C. Williamson's theatres, courtesy of J. & N. Tait the tour promoters, also broadcast over 2FC, and in Melbourne Farmer and Company became majority shareholders in A-class station 3LO, previously run by the Broadcasting Company of Australia.

The shareholders in Dominion Broadcasting Co., the new company controlling 3LO, were Farmer and Company



The earliest known photo of an Australian radio broadcasting control room — 2FC's control room, which began service on December 5, 1923. (Courtesy AWA).

40%, J.C. Williamson and J.& N. Tait 40%, Herald and Weekly Times 15%, and Buckley and Nunn Ltd 5%. On 1/3/1928 the other Melbourne A-class station, 3AR, was also taken over by Dominion Broadcasting.

Move to Pennant Hills

In early 1926, the transmitter of 2FC was transferred to the large AWA transmitting centre at Pennant Hills and operated by AWA under lease. (In typical confrontationist attitude, Fisk refused to accept 2FC Limited as authorised to pay service fees due to AWA, and demanded a guarantee direct from Farmer and Co.) The original wavelength of 2FC, 1100 metres, was well down the scale and limited its broadcast coverage at night, so when the move was made the station changed to 442 metres (678kHz).

Frequency stability and measurement in this period was not terribly exact, and both 2FC and 2BL are listed in various sources at frequencies which are only within a metre or so of their nominal locations. By January 1928 new studios for 2FC had been built in premises owned by J.C Williamson in Market St., next to that company's 'Her Majesty's Theatre'.

A number of business dealings between 1925 and 1928 resulted in J.& N. Tait becoming part of J.C. Williamson, and the *Sun* Newspaper bought out David Jones' share of Broadcasters Ltd. A new company was incorporated on 17/11/1927 — 2FC Limited — to take over the broadcasting business of Farmer and Company with a share split of 50/50 between Farmer and Company and J.C. Williamson. The licence of 2FC was transferred to it on 1/12/1927.

The new company entered into negotiations to take over 2BL, but 2BL held out for 45% of the combined revenue, until an independent arbitrator suggested a 60/40 split between 2FC and 2BL.

As a result on 1/1/1928, 2BL and 2FC agreed to amalgamate and were combined in a new company, the 'New South Wales Broadcasting Company' on 14/8/1928. Mr George Wright, Chairman of Farmer & Company, became chairman of the new company and the intention was that upon his retirement a chairman would be appointed by 2FC or 2BL for alternate years.

In December 1927, 2FC Limited commenced negotiations with Otto Sandel, owner of 2UW, with a view to acquiring a commercial B class station. A new company was formed, 'Radio Broadcasting Limited' with 1/3 equal shareholdings between Farmer & Co, J.C. Williamson and J. & N. Tait, and W.H. Paling & Co, to take over and manage 2UW.

The licence of 2UW was transferred to the new company on 12/4/1928, and the company officially took over management on 22/6/1928. Later, Palings bought out the other two shareholders and on 16/10/1933 sold 2UW into the Commonwealth Broadcasting Corporation.

1927 Royal Commission

In January 1927 the Government announced a Royal Commission into all aspects of wireless broadcasting in Australia, following listener dissatisfaction with the limited coverage and programming of the stations, arguments over licence fee disbursements, and concern over the dominant and stifling role of AWA.

The Royal Commission recommended that the licence fees be pooled and the A class stations should co-operate to provide a better, wider service. That meant the large city stations would be subsidising the smaller country stations. Discussions between the stations and the Government broke down, so the government established its own National Broadcasting Service on 26/7/1928.

The transmitting licences of the A class stations were cancelled as they came up for renewal, and their assets such as transmitters and studios were purchased or leased by the government and put under the control of the PMG. 2FC and 2BL were both taken over and compensation of approximately £20,000 (2FC) and £10,000 (2BL) paid. The other stations acquired by the PMG were 3AR, 3LO, 4QG, 5CL, 6WF and 7ZL.

All the stations which were taken over applied for further compensation of £60,000, claiming for the premature loss of their licences, and there were allegations in Parliament that the new General Manager of the Australian Broadcasting Company, Mr. Conroy, had influenced the Government to pay the compensation because of his links as the previous Manager of 3LO.

Programme consortium

Apart from two stations which were leased from and run by AWA, the PMG provided technical services, with programs supplied under contract by the Australian Broadcasting Company. The Australian Broadcasting Company was a consortium of Union Theatres, Fuller Theatres and J. Albert and Son, which won the tender to manage and program the National stations.

That contract expired in June 1931 but was extended to June 1932, by which time the government had decided to reorganise Australian broadcasting — for the fourth time in nine years. The Australian Broadcasting Commission Act was passed in May 1932 to manage the national stations, now up to 12, and guide the programming policy.

Charles Lloyd Jones, then 54, was appointed as the part-time Chairman of the Australian Broadcasting Commission, or ABC, when it came into being on 1/7/1932. Lloyd Jones had shown a strong interest in broadcasting, had developed the retail side of it through his stores and was one of establishment's artistic people.

Although the Chairman's position was paid as a part-time job, he spent much of his time on ABC matters. He remained in the position for only two years, citing the need to concentrate on the management of David Jones Ltd during the recession as his reason for resigning — although he did not enjoy a happy time with the ABC. He had to withstand constant criticism from the public, obstruction from the entrenched public service mentality and harassment from the politicians.

David Jones and Farmers retreated from their involvement in broadcasting. But the other players, the entertainment and cinema giants, newspapers and music tycoons bought into the B class stations — within restrictions on ownership imposed by the Government — and participating in large programming networks such as the Macquarie Broadcasting Network, and the Commonwealth Broadcasting Corporation (formed by the shareholders in the previous Australian Broadcasting Company).

Radio broadcasting was now well established in Australia, after its faltering start, and would soon enter its 'golden era'. But that's another story...

In closing, I would like to thank Mrs B. Horton, David Jones Archivist, Mr. G. Tranter, ABC Assistant Archivist, and the staff of the Australian Archives for their help and interest, which made this article possible. ❖

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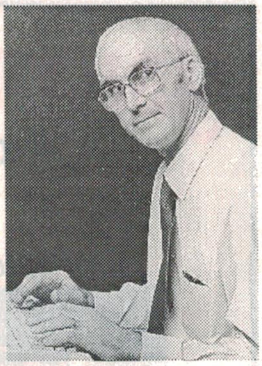
READER INFO NO. 8

FORUM

Conducted by Jim Rowe



When the sound of capacitors is definitely NOT the sound of silence...

Well, as I commented at the end of last month's column, we seem to have been dragged back once again to another of those subjects so dear to the hearts of true-blue hifi enthusiasts. In this case it's the question of which kinds of capacitor should *not* be used in amplifiers, because of their tendency to produce distortion. (It makes a change from the one about fancy cables, at least!) I also have to apologise for our inadvertent publication of a 'Circuit and Design Ideas' item that could possibly contribute to a tragedy, in some circumstances.

Like the definition of 'good children' when I was a kid, the capacitors and other passive components in an audio amplifier are basically expected to be 'seen, but not heard'. In other words, they should perform their roles inside the amplifier in a totally 'transparent' manner, adding no colouration of their own. But of course there's a fair amount of evidence that *some* kinds of capacitor *do* introduce at least audible distortion, as Melbourne engineer Tean Tan noted in his article of September 1992 describing a valve amplifier design.

You may recall that I published a letter from fellow Melbournian engineer Graham Byrnes in the June column last year, criticising some of the claims made by Mr Tan. Then in the September column I published Mr Tan's reply, which referred to a couple of papers on the subject of capacitor behaviour written by US technical author Walter Jung and researcher Richard Marsh, and published in the February and March 1980 issues of the US magazine *Audio*.

Not surprisingly, I suppose, a number of readers have responded to both Mr Tan's further comments and those of Graham Byrnes. A couple of people very kindly sent in copies of the articles from *Audio*, as I mentioned at the end of last month's column, and one also sent in some further information of relevance. So one way and another, it seems, the subject seems to be crying out for some further coverage...

That STD-bar circuit

Before we do so, though, there's an urgent matter I should deal with first.

In the October issue, we published an item in the 'Circuit and Design Ideas' column contributed by a reader in New Zealand. It was a circuit designed to prevent unauthorised use of a tone-dialling telephone for making STD and ISD calls, and it basically worked by sensing the DTMF tone-pair for a leading 'zero', and disconnecting the call if it found one.

Now this seemed an innovative idea to us, even though the number of private phones in Australia currently using tone dialling is probably not great. That's why we published it. However as soon as the October issue had been published, we received a veritable flood of calls, letters and faxes — all castigating us for our stupidity and irresponsibility in publishing it, and in some cases claiming we would be responsible for a spate of tragedies and fatalities.

Why? Because we had forgotten that throughout Australia, the code for all emergency services is '000' — not '999', as it appears to be in New Zealand. So in Australia, the circuit would not only prevent people from making STD and ISD calls, but also from making emergency calls — and could therefore conceivably result in tragedies as a result.

Presumably our New Zealand contributor was not aware of this difference — but as our critics have pointed out, *we* certainly should have been. We should also have noticed, and at least drawn the attention of readers to the fact that if built, the circuit could not have been connected to a telephone wired to the public switched network, without breaking the law — because it would not be an 'approved attachment'.

What can I say, apart from admitting that we goofed, and goofed badly? As the one who must be held responsible, it's ultimately my fault that we let the item slip through, and didn't spot either its hidden potential for tragedy or its illegality. So I must apologise on both scores, and we'll try to prevent this kind of mistake from happening again.

Perhaps I should also warn all of our readers against building the circuit up and connecting it to their phone — not only because this *would* be illegal, but because they might well regret having done so if an emergency should arise.

Luckily, perhaps, not many private phones here seem to be connected to exchanges equipped for tone dialling — so the circuit probably doesn't have all that much appeal here as yet, in any case. Still, publishing the circuit gave our critics a good opportunity to 'jump on us', didn't it?

By the way, the PABX switchboard here at Federal Publishing is programmed to automatically 'bar' STD and ISD dialling-out from most of the extensions, and I imagine the PABX's of many other firms are similarly programmed. Presumably this would make it very difficult to dial '000' in the case of an office emergency, as well...

Back to capacitors

Now let's get back to capacitors and the sounds they make — or are alleged to make, at least.

Among the people who responded to Tean Tan's letter in the September issue was Graham Byrnes, the man who had taken issue with Mr Tan in the first place. So in fairness, let's look first at what Mr Byrnes has to say, in his own follow-up letter:

I see Tean Tan has returned to take up my gauntlet on the sound of capacitors. Since the appearance of my letters seems to amuse my students, a considerable number of whom are studying electronics

engineering, I thought I may as well throw back some comments.

First, I must admit that although I am aware of the article by Jung and Marsh, I have not read it. However there is another article, by H. Baggot (Elektor Electronics, February 1992), in which similar issues are discussed and measurements taken. Let me first quote:

'The third harmonic distortion of capacitors used in a high-pass filter with a load resistance of 100 ohms, measured at 250Hz, was less than 0.001% for all film types, and varied between 0.011% and 0.025% for electrolytic types.'

This was with capacitors of 2.2uF. He also showed that distortion increased with a decrease in frequency or load impedance. Note that in Mr Tan's amplifier the coupling capacitor operates into one megohm, in parallel with the triode grid capacitance.

Mr Tan invokes dissipation factor (DF), dielectric absorption (DA) and temperature variability. It should be noted that the first two of these are linear effects, and as such have absolutely no effect on the harmonic distortion. In fact DF is the ratio of effective series resistance to the imaginary component of the impedance. Since DF is approximately proportional to frequency, the stated 0.3% - 1% is meaningless, but if I assume it was measured at 1kHz, the calculated ESR in Mr Tan's coupling cap would still be less than three ohms had he used an MKT cap instead of MKP. Hardly a significant amount if the input is fed by a volume pot, or even direct from the output of a typical CD player, and absolutely trivial given the load impedance.

DF is crucial in low impedance circuits where power dissipation is a concern, such as power-factor correction capacitors and speaker crossover capacitors (my loudspeakers use MKP capacitors, originally destined for fluorescent lighting power-factor correction).

According to the measurements by Baggot, the temperature variations for MKP and MKT are nearly identical in magnitude between 20° and 80°C, but opposite in sign. In each case the total variation over this range is about 2.2%. With coupling capacitors, one is only concerned that the capacity be sufficient, not with its precise value. In the valve amplifier of Mr Tan, the high-pass filter formed by the coupling capacitors will cause a change in response of less than 0.5% at 20Hz, or 0.02dB, over the full 60° range.

Of the three mechanisms, only temperature dependence in combination with dissipation can cause harmonic distortion, as a large signal causes heating which leads to a capacitance change. This would produce a non-linear relationship between stored charge and voltage. However, given the level of dissipation involved (in the order of a pica-watt for 1V RMS input), this can't be taken seriously.

In my opinion only DA is potentially significant. Its effects are rather difficult to understand, since it produces a long term time averaging effect. This might be likened to the phase distortion of a second-order filter tuned to a very low frequency. Of course, a loudspeaker is at best a second order high-pass filter tuned to its resonant frequency (for a sealed speaker: ported designs are typically fourth order), so the effect is likely to be swamped by phase errors from that source. In the case of a transformer coupled amplifier, yet another source of phase error is present.

I cannot imagine any way that DA (which is usually modelled by a series combination of capacitor and resistor parallel to the ideal capacitor) could 'compress the dynamic range', unless Mr Tan has a rather original definition for dynamic range. Compression is a

non-linear process, and non-linear processes tend to show up in the THD measurements.

The above should not be taken to mean that I discount any subtle effects due to capacitors. In particular electrolytic capacitors, particularly if not properly biased, can introduce diode type effects. Moreover, my experience suggests they are rarely biased properly in consumer equipment (or EA project designs). Nor do I think it is inappropriate to use better quality components on a 'just in case' basis, or because the designer simply believes they sound better. For that matter, my own stereo (home-built from D-A converter to loudspeakers) is direct coupled from the D-A chip to the loudspeaker crossovers, and uses polycarbonate capacitors in the DC-servos.

A correspondent to one of the electronic bulletin boards concerned with audio (Graeme Gill) has recently suggested that on the basis of data concerning noise masking and hearing thresholds, an amplifier would need to achieve a S/(N+THD) ratio approaching 110dB to be undetectable in all circumstances. So there are many subtle possibilities still open.

However, to state that polyester capacitors cause 'high distortion' is a simple, testable assertion. It has been tested by Baggot, and in that case was shown to be false.

Also, that 'most audio enthusiasts are well aware' of something doesn't interest me in the slightest, since as a community 'most audio enthusiasts' have shown themselves to be exceptionally gullible. When such claims are made in the context of an amplifier using an iron-cored transformer in the output (with the concomitant problems of bandwidth limiting, non-linear magnetisation, premature saturation due to DC biasing by quiescent current imbalances) and harmonic distortion exceeding 2% mid-band (i.e., only 34dB down), I can only describe them as laughable.

Now to another matter: You recently requested feedback on the content of the magazine. Might I suggest that as an addition to the many free 'introduction to electronics' articles that appear in EA, it would be useful to have some 'current technology updates'.

For example, it was some time after hearing of current-mode op-amps that I was able to establish how one functioned (I'm a mathematician, not an engineer) by looking through some of the academic electronics magazines kept in the library of the university where I work. Most people do not have that luxury, and it is frustrating to read in 'Solid-State Update' about some new device whose function is only barely hinted at.

Oh, and a design for a high quality FM-stereo tuner would be nice, too, but given the problems of obtaining parts, etc., etc., I can well understand if that has to stay on my wish list!

Thanks for those comments, Mr Byrnes. It looks as if you're still not at all convinced by Mr Tan's claims about audible differences between polyester and other plastic film capacitors — especially when the amplifier concerned uses output coupling transformers, as did Mr Tan's valve amp. Still, you do seem to agree that it would be unwise to dismiss *all* suggestions regarding subtle audible effects associated with the various types of capacitor...

I note that you have also worked in a couple of suggestions regarding the magazine itself, in response to Peter Phillips' invitation in Information Centre. Fair enough, although your suggestion that we have 'current technology updates' seems to imply that we haven't done anything like this before. In fact we've already done some, including articles recently on I^2C and the ACCESS bus, CDMA spread spectrum communications, and direct digital synthesis or 'DDS'.

Much time, effort

We can certainly try to do more of these, as I agree they're worthwhile. The only problem is that this type of article can take a lot of time and effort to produce; you have to do a fair bit of research first, to understand the subject yourself, and then spend as much effort again working out how to explain things clearly. I suppose that's why we haven't produced as many of them as you might like, Mr Byrnes!

But we're digressing, of course. Let's get back to the subject of capacitors and their sounds. Another letter on this topic turned up from yet another Victorian reader, Mr Mike Hammer of Mordialloc. Mr Hammer is an electrical engineer, and as well as sending me a copy of the second Jung and Marsh article also sent in a copy of some other published material — some of which I'll refer to shortly. First, here's his own comments:

I am writing on the subject of capacitors and their effect on sound.

Whilst I agree that fancy audio cables must be treated with a fair degree of scepticism, there are objective tests that can be done to show that various capacitors are not as linear as you would expect. One such test is described in April 1986 Hi-fi News & Record Review, and consists of a reference and a test capacitor on each differential input of a precision operational amplifier.

I have tried these tests, and measured up to 3% residual output from a 1V p-p 1kHz sinewave input using a 47nF polyester capacitor as the test capacitor and an equivalent polystyrene capacitor as the reference. Two capacitors of the same dielectric give almost no residual.

Whilst I have not yet done a subjective back-to-back test, there can be no dispute that one of the above capacitor types is quite non-linear, and I will be using all polystyrene or polypropylene capacitors in future hifi gear that I build.

I hope the above is of interest to your readers. I have enclosed some reference material for your reading pleasure!

Thanks for your comments too, Mr Hammer, and also for sending those copies of the articles. It's interesting that you have carried out some of these tests yourself, and have found them to show significant differences between the various types of plastic film dielectric capacitors.

For the benefit of other readers, I have re-drawn the test circuit given in the *Hi-fi News & Record Review* article, and reproduced it here as Fig.1. By the way, the article concerned is attributed to Walter Jung (yes, the same one) and John Curl, and was apparently published originally in the US magazine *The Audio Amateur*. The basic test circuit was apparently developed by Walter Jung, with later refinements by John Curl in consultation with Scott Wurcer of Analog Devices.

Bridge arrangement

As you can see from Fig.1, the Jung/Curl test circuit is essentially a bridge arrangement, which compares the performance of a test capacitor (C_{TEST}) with that of a reference capacitor (C_{REF}). The two caps are used as the upper arms of a bridge, which is fed initially at least with a rectangular waveform from a pulse generator. The lower arm of the bridge on the C_{TEST} side is formed by load resistor R_L, with a value selected in the range from 200 ohms to 5k, while the lower arm on the C_{REF} side is formed from resistor R2 (100 ohms) plus a combination of three variables with values of 10k, 200 ohms and 10 ohms (all collectively called R_{ADJ1}), to allow primary balancing of the bridge. A precision differential amplifier with calibrated gain K (such as the Analog Devices AD624) is used to sense any bridge un-

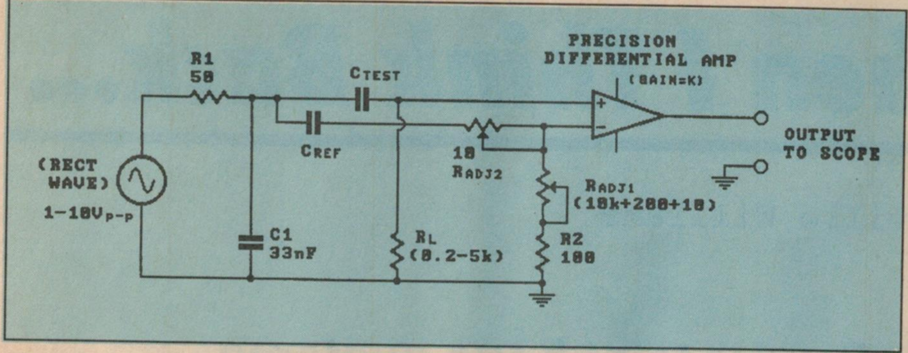


Fig.1: The capacitor test/comparison circuit used by Walter Jung and John Curl.

balance voltage, and provide a single-ended output to drive a scope.

To allow for the fact that the test capacitor may have a higher equivalent series resistance (ESR) than the reference cap, variable resistor R_{ADJ2} (10 ohms) is connected in series with C_{REF} to allow this source of unbalance to be compensated. Capacitor C1 is used in conjunction with R1 (the output resistance of the pulse generator) to limit the bandwidth of the bridge input signal to about 100kHz, to minimise instrumentation problems and also give a more realistic simulation of performance for audio signals.

The basic idea seems to be that with the bridge fed with a rectangular-wave signal of somewhere between 1V and 10V peak to peak, the variable resistors R_{ADJ1} and R_{ADJ2} are adjusted to give minimum output from the op-amp as measured on the scope. This balances the bridge in terms of the time-constants (R x C) on each side, and also in terms of the ESR of the two capacitors.

The remaining output signal (which can be measured and expressed as a percentage of the bridge input signal) is a measure of the residual bridge unbalance, and is taken in broad terms to indicate the difference in performance between the two capacitors. If you have two polypropylene or polystyrene caps, for example, there's almost no output at all.

The *HFN/RR* article shows photos of the input and output signal waveforms for various kinds of capacitors, compared in most cases with a polypropylene reference cap. The highest (= worst) outputs were with electrolytic (3-12%), solid tantalum (about 1%) and high-K ceramic (2.4%) caps, while the lowest/best output was with Teflon and polystyrene caps (around 0.001%). Polyester/Mylar caps gave figures around 0.1%, apparently.

So there do seem to be *measurable* performance differences between the various kinds of capacitor, and with signals in the audio spectrum. And Jung and Curl note that once the bridge circuit has been balanced, the rectangular wave test signal can be replaced with a normal audio signal, to allow the 'difference' or 'error' signal to be *heard* as well.

Jung and Curl seem to assume that these differences are predominantly due to differences in the DA (dielectric absorption) behaviour of the various dielectrics. However I note that in the following issue of *HFN/RR* (May 1986), a Dr Malcolm Hawksford suggests that this may be an over-simplification of the situation.

Dr Hawksford points out that Jung and Curl are using a very simplified model for the capacitors, with essentially just a perfect C in series with a resistor representing ESR. This tends to make primary bridge balancing only possible at a single frequency, whereas the rectangular wave test signal is really composed of a number of frequencies: the fundamental and odd harmonics. He argues that the test would therefore be improved by using a more realistic capacitor model, which allowed balancing for such parasitic elements as the series inductance and shunt resistance of the capacitors.

Still, Dr Hawksford *does* agree that even if there's a doubt about the exact composition of the error signal produced by this test circuit, and the aspects of capacitor behaviour which cause it, the fact that the error signal exists when one capacitor is compared with a high-quality unit *is* fairly conclusive evidence that the second capacitor is of poorer performance.

By the way, I *have* finally managed to read through the two articles by Jung and Marsh (whew!), and as Mr Tan noted their testing certainly seemed to suggest that the performance of metallised polyester/Mylar capacitors was significantly poorer than polypropylene, polystyrene or Teflon caps — with Teflon types being the best of all, from an audio point of view, and polystyrene next best. Their conclusions certainly leave you in no doubt that they recommend replacing polyesters with these types, as a relatively low cost way to improve the sound from many amplifiers and preamps.

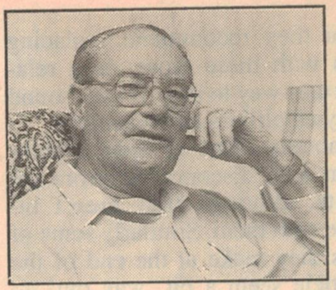
To be honest, some of their conclusions seem a bit disconnected from the test results, although they aren't incompatible with them. Similarly some of the claims they make at the end of the second article seem a bit 'way out' — such as a claim that even one polyester cap in the audio chain can be clearly 'heard' in terms of its sound degradation. But on the whole, they do seem to have found significant performance differences between the various kinds of plastic film capacitor, at audio frequencies...

So there you have it. The bottom line seems to be that there *are* measureable differences between polyester caps and polypropylene or polystyrene caps, at audio frequencies, and a fair amount of evidence that the differences can be heard, as Tean Tan claimed — at least by those blessed with 'golden ears'.

If you're not happy with the sound from your hifi system, then, it may be worth replacing any polyester caps in the signal path with polypropylene or polystyrene caps — if you can afford them, and if they'll fit in. (They're usually rather bigger, as well as considerably more expensive...)

Whether or not this kind of upgrade would be justified in the case of a valve amplifier, with all of the additional problems associated with output transformers, is of course another matter — as Graham Byrnes has pointed out.

And that's it for another month, folks. See you here at the Forum same time next month, I hope? ❖



When I Think Back...

by Neville Williams

MAILBAG MONTH: Carrier telephone systems, avionics, 'Smithy' and the 'Knickebeins'

Writing from Wahroongah in NSW, Don Taylor reminds us that progress in electronics has not been confined to radio, video and consumer audio — the topics which have largely dominated these columns. Over much of the same timeframe, telephones have evolved from the primitive 'dynamo' and/or 'candlestick' variety, with manual exchanges, to automated electronic and optical carrier networks offering immediate local, interstate and international communication.

Whether we need to be reminded is another matter, I suppose. I well remember the country village in which I spent my boyhood, where phones of any kind were few and far between. Those that did exist — in the railway office, policeman's cottage, hotel, garage and store — were connected to a switchboard in the 'post office', which was one room in the house where the postmaster lived with his family.

'Ringing up' involved cranking a handle to attract his (or his family's) attention, so that someone could plug your — the caller's — line into the appropriate 'jack' and alert the party at the other end with a further crank handle on the post office switchboard.

When I mentioned as much to Don Taylor, he indicated that he had similar recollections of the exchange in Mona Vale, now a well known seaside suburb of Sydney. Crank handle and all, he said, was installed in one corner of a local store and tended by the storekeeper and/or his family.

These days, most Australians have access to a phone and are encouraged by concessional rates to talk to 'family and friends' here, there and everywhere — from Gundagai to Greece.

Don Taylor's prime purpose in writing was to comment on the late L.P.R. Bean and Stromberg-Carlson (A'sia), as featured in these columns in April and September last. Having done so, he went on to talk about another memorable chief executive and another company which had been set up to manufacture telephone equipment, much of it involving carrier type technology.

One call per pair

For those who are strangers to this subject, I should perhaps explain that telephone wires were originally meant to carry only telegraphic code and/or audio signals, each pair of wires serving, in the latter case, to interconnect the microphones and earphones at either end, along with the call-bell system.

A fair amount of supplementary gadgetry was involved and the number of calls which could be accommodated simultaneously between any two locations was limited to the number of 'pairs' available between them: one conversation at a time per pair. As the demand for phone facilities increased, it became progressively more difficult and/or uneconomic to install and maintain the requisite number of pairs throughout and between the population centres. Photos from the 1920's and 30's show telephone poles festooned with an incredibly complex mass of crossbars, insulators and wires. A typical picture, dated 1912, in the *Macquarie Book of Events* shows a single pole carrying 20 pairs of crossbars, each supporting eight insulators. Twelve workmen were concentrated around it: seven up amongst the wires and five on the ground!

A potential answer to the problem emerged around 1925, with the realisation that phone lines could be made to carry signals in the low-

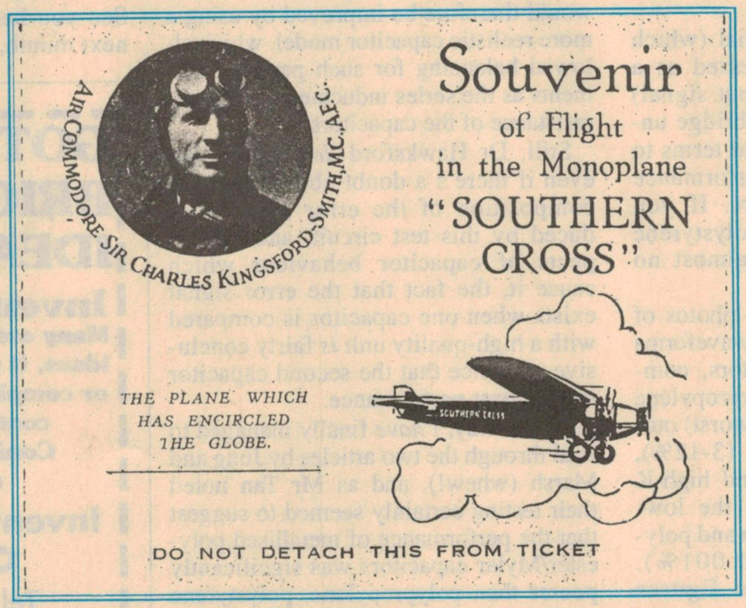


Fig.1: Any number of readers will remember having saved up 'ten bob' ($1) in the 1930's for a joy flight, but few will have had the privilege of a flight in the 'Southern Cross' with 'Smithy' at the controls. This souvenir is from a 1934 flight...

Fig.2: From the June 22, 1928 issue of 'Wireless Weekly', this picture shows Ulm (left) and 'Smithy' fronting up to a 1920's style transverse current carbon (Reisz) microphone. An 18-hour unbroken coverage of their trans-Pacific flight by 2BL set what was an Australian — and probably a world — record at the time.

RF (supersonic) range which could be modulated with audio, speech or tone, in the manner of ordinary radio signals. By relying on filters to limit their individual bandwidth, multiple modulated 'carriers' could presumably be carried by each pair without mutual interference. The idea was sound, but implementing it proved to be a long drawn-out process.

Nowadays, the 'multiplexing' of encoded information over cables is a science in itself involving speech, music, video and all manner of data over telephone pairs, coaxial cables, fibre-optic cables and satellite links — separately or in combination. Right now, the Federal Government is agonising over the various options as a basis for Pay TV.

But 50 years ago, engineers were still sorting out basic technology the hard way — how best to go about it, and how to create the specialised circuits and components that would be required. That's the background against which Don Taylor's letter should be read. What follows is largely Don's original text, with a minimum of editing on my part:

Don Taylor thinks back

The other remarkable character I recall from the 1950's was Thomas Samuel Skillman. He was an Englishman, a Cambridge graduate who, in the 1950's, was employed by Philips in Holland...

Not long before the start of World War II, Philips secured a contract with the Australian Post Office for the development and installation of a 17 channel carrier-on-a-cable duplex system to provide a telephone link between Sydney and Maitland, 150km or so to the north. A similar system was later to link Sydney and Orange, in the west.

Work on the system was still in the early stages when Germany invaded Holland. Skillman, together with some of his associate engineers, managed to escape with the complete design data and, after complex negotiations, came to Australia.

Here, with financial assistance from the Government, Skillman formed a company, Communication Engineering Pty Ltd, built a factory in a disused sandstone quarry in the Sydney suburb of Cammeray, and set about producing the entire system on the spot.

According to Don Taylor, it was extraordinarily sophisticated equipment for the time. The requisite coaxial cables were laid underground, in a special conduit which was filled with an inert gas (probably nitrogen) at slightly above atmospheric pressure. This provided an environment which promised greatly extended life for the cables.

Designated channel spacing was 4kHz which, with SSB (single-sideband) technology, provided an effective audio channel bandwidth from about 400Hz to 3.8kHz. The top frequency transmitted would be about 75kHz.

It was an enormous advance on anything that the Australian Post Office had in service. Up to that time, their only carrier systems consisted of some fairly primitive three-channel installations using existing open-wire circuits and (Don thinks) both sidebands.

Quality control problems

Skillman, with extraordinary drive and engineering ability, established his manufacturing enterprise in the face of enormous difficulties. Although the general idea of the equipment was fairly conventional, components such as inductors, capacitors, resistors and transformers all had to conform to the most exacting specifications.

Conventional, locally made components, as used in the radio industry, were totally inadequate — as, indeed, they proved to be a few years later, when TV receiver production got under way.

The carrier telephone system required large numbers of band-pass, low-pass and high-pass filters, as well as modulation and demodulation oscillators. Not only did these have to be manufactured and adjusted to fine tolerances but they also had to exhibit a very high degree of stability.

(Don should know. Questioned by telephone during the preparation of this article he said that, as a graduate in mechanical-cum-electrical engineering, his job at Communication Engineering Pty Ltd had been to supervise the production and later the testing of filter modules).

The tolerances were far tighter than for anything needed or even imagined for the production of domestic radio receivers.

To achieve such standards, all components had to be specially manufactured on the spot. For example, all capacitors used mica as the dielectric. The mica came in blocks and hand-picked operators were trained in splitting the mica down to the specified thickness, each piece being carefully checked with a micrometer.

The mica sheets were then blanked into squares in a press to form individual plates. Half the number underwent a vacuum deposition process to provide a thin film of aluminium. They were then assembled, using uncoated squares to serve as dielectric spacers. Duly clamped and tested, they were vacuum wax impregnated and pitch dipped.

Some of the inductors were wound on toroid cores, others in so-called 'pots', which were adjustable.

Complete filters were normally assembled in steel cans, tested, pitch filled, aged at high temperature, tested again, then closed by soldering a lid in place.

As such, they left little scope for subsequent internal servicing!

Local design, technology

On site support facilities included a machine shop, plating, painting, bakelite moulding, etc., along with the usual infrastructure of engineering, drafting, purchasing, sales and accounts.

Last but not least, the complete carrier systems were wired and critically performance checked by Post Office inspectors. Significantly, the technology for all this was put in place during the war.

After the war, Skillman formed a new company, T.S. Skillman & Co Pty Ltd and embarked on new projects connected with long-line telephone equipment. These included custom built line filters, program channel equipment for the transmission of radio programs and specialised equipment for the Department of Civil Aviation, which provided multi-channel telephone circuits for onward transmission by radio link. But that was not all.

In the 10 years or so following the war, one of the basic bottlenecks impeding the provision of telephone services was overload of the 'junction' cables linking the various suburban exchanges. Working with Post Office engineers, Skillman and his team found that many pairs already in the junction cables could transmit the higher frequencies required for a carrier system, without crosstalk or compromising audio quality. Out of this came a highly innovative but practical design for the so-called 1+4 'junction carrier' system.

Another innovative development was the design and manufacture of a three-channel carrier system for use on open wire lines in the outback. This was the first design in which crystal-controlled oscillators were used for modulation and demodulation. With the earlier L/C oscillator technology, temperature effects had posed a problem, on occasions necessitating resort to temperature controlled crystal ovens.

A still further refinement was the option of using two carrier frequencies for each channel, enabling the use of either lower or upper sideband. The development made it easier to achieve the specified tolerances for audio frequency response and crosstalk.

Fig.3: Built by Jack Duffy of Sydney, for a projected 1933 Trans-Tasman flight, this 50 watts transmitter/-receiver could handle both voice and Morse code. Featured by 'Wireless Weekly' in October 1932, it was apparently one of a number that John Stannage ultimately rejected.

Finally overwhelmed

Despite such initiatives, Skillman's business eventually fell victim to the enormous advances in technology and the difficulty of competing with the large multi-national corporations which dominate the telecommunications industry.

Don Taylor says that Skillman was always conscious of his firm's vulnerability and frequently referred, with a degree of paranoia, to 'the ring' which, he said, the international cartel maintained in order to drive smaller competitors like him out of business!

But Skillman himself was a larger-than-life character. He was a huge man physically, well over six feet (183cm) tall, weighing 20 stone (127kg) or more:

I will never forget my first meeting with him. It was a hot summer's day and he sat in his office with his sleeves rolled up. As my eyes fell on this huge man I thought: that's what it means to have arms like hams!

It was not only physical size which made Skillman such a formidable character. His dominant personality, powerful cultivated English voice and enormous intellectual talent made him a person to be reckoned with. He also had the ability to surround himself with loyal, talented and hard-working people. His staff included scientists, engineers, a lawyer (Laurie McGinty, who later became Mayor of Willoughby and a member of State Parliament) a patents expert and many others. He was a demanding person to work for, and sometimes unpredictable but most who did so found the experience rewarding.

Don Taylor concludes:

To my regret, I have lost touch with the people at Skillman's, but I still remember many of them. When the business closed in about 1961, those remaining were scattered to the wind.

Harry Stewart, I know, went to STC. Others who come to mind were Jimmy Stuart MSc, a gentle and talented scientist; Bruce Veitch, Frank Melvan, Barry Boden, David Goldby, Ken Stanton, Vince Power, Bill Fowler, Ross Littlemore, Truxtan Cooper, Herman Kanters, Allen Webster and others. Most of these people would almost certainly have continued their career in some part of the electronics industry, and would have their own stories to tell.

Skillman himself remained in Australia, living in Mosman, NSW. He interested himself in various esoteric activities — including, I think, the Mensa Society, a group of neo-eccentrics claiming to have inordinately high IQ's. To the best of my knowledge, he died about 10 years ago, survived by his wife and two daughters.

(For former workmates who may want to contact Don Taylor, his address, published with his permission, is 96 Burns

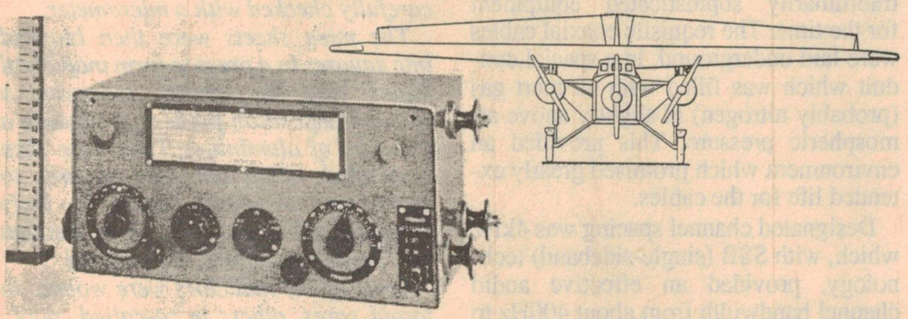


Fig.4: Produced by Philips of Holland for the Dutch KLM Aerial Mail Service, this receiver was designed for use with a V-antenna strung between the wing tips and tail, as shown. Mated with an equally modern looking crystal-locked voice/code transmitter, it was described in Wireless Weekly for December 9, 1932 as the 'Last Word in Radio for Smithy".

Rd, Wahroongah, NSW 2076. Telephone (02) 489 2534.)

So much for carrier type telephony. Now for a complete change of subject:

More about 'Smithy'

In June and July 1992, I recounted the exploits of (Sir) Charles Kingsford-Smith and his associates, with particular emphasis on the 'Old Bus' — the *Southern Cross* — and the relevance of two-way radio to his pioneering flights.

Mention of his incidental barnstorming tours around the countryside stirred the memory of Fred Whitehouse of Muswellbrook, NSW, and of a former *EA* staff member Jim Yalden, who currently operates an electronics service business in Milton, NSW. Both recalled having had a joyflight in the *Southern Cross* in the early 1930's and having kept the ticket against the day when it might become a fragment of Australian history.

It so happens that Fred's ticket was the better preserved of the two, and it's the one which Editor Jim Rowe has done his best to reproduce in the accompanying Fig.1.

By chance, Jim Rowe also came across several more articles about Smithy in old copies of *EA*'s ancestor *Wireless Weekly* and, while I do not propose to discuss them at length, they are certainly worthy of mention.

In the issue for June 15, 1928, a *WW* staff writer asks and answers the question: "Would the (recent) trans-Pacific flight have been successful without radio?" He concludes "It is doubtful".

He stresses that, under less than ideal flying conditions, a plane could not navigate safely over open ocean using only the resources (then) applicable to shipping. Deprived of reliable sightings, a pilot did not have the ultimate option of waiting around until conditions improved. In 10 hours aloft, a 30mph cross wind, undetected, could carry a plane like the *Southern Cross* 300 miles off course — sufficient to miss an island destination altogether.

Readers were also reminded that Marconi and Fisk/AWA had recently demonstrated the properties of directional high frequency wireless beams between the UK and Australia, and that Smithy had flown the 2400-mile (3900km) leg from San Francisco to Honolulu along just such a beam.

The writer envisaged more ambitious systems spanning the Atlantic and Pacific oceans, with the main beam being intercepted every 300 miles or so by transverse beams, acting as markers, each modulated with its own distinctive code letter. 'Invisible lighthouses in the sky' he called them. (More about them later).

Broadcast coverage

Although more than 60 years have passed since that first historic flight across the Pacific, I can still remember the drama of the live radio coverage. Only now, however, do I realise how little of it I could really have heard, because of the need to conserve batteries.

It was a case of switching on at intervals to verify that signals from the *Southern Cross* were still being received, then switching off again.

Among the items unearthed by Jim Rowe was a detailed contemporary account of the broadcast coverage, published in *Wireless Weekly* for June 22, 1928, in an article entitled 'How 2BL Broadcast the Good News'. The station had been the first in Australia to announce the plane's arrival in Hawaii, and had kept in touch with it throughout the entire next leg from Hawaii to Fiji.

En route, the *Southern Cross* passed through a storm so violent that Lieut.

Fig.5: Made by Hallicrafters Incorporated of Chicago, the S-27 receiver had 15 valves and tuned from 27MHz to 145MHz in three ranges. It also demodulated FM, and allowed the British to finally detect the German Knickebein beams.

Warner found it difficult to operate the Morse key. He had kept the key switch closed, however, so that his listeners would be reassured by the wavering buzz of the carrier, as the trailing antenna whipped around in the gale — varying the transmitter frequency as it did so.

At the receiving end, the entire episode was monitored by 2BL's Chief Engineer Raymond Allsop, and his assistant, both experienced operators. Throughout the long hours, they relayed the sound of the incoming carrier to the studio, interspersed with actual Morse Code transmissions and the transcribed text, as jotted down on a note pad.

In the studio, the coverage was intermixed spontaneously with back-up program material, with a summary of the plane's progress every hour, on the hour.

When the plane took off, a few days later, on the final leg from Fiji to Sydney, 2BL broadcast the news within four minutes. It then stayed on air for an unbroken 18 hours, mixing messages from the plane with phone-in messages from the aviators' families and comments from studio staff plotting the plane's progress on Admiralty charts (Fig.2).

Radio's vital role

As the plane approached Mascot, Sydney, and a welcome by a reported half-million people, 2FC took up the coverage, providing a supplementary channel on 28.5 metres.

In all, the broadcast went to air through A-class stations Australia-wide, through 5SW in England, WGY Schenectady (USA) and WMAK Buffalo.

Remembering also the drama of 'Coffee Royal', the loss of the *Southern Cloud* and the abortive mail flight to New Zealand, it is difficult to escape the conviction that broadcast coverage of such events did much to generate a public — and political — perception that planes used for anything but local flights must have adequate radio back-up for both communication and guidance.

But what did 'adequate' signify? In practical terms, and in Smithy's day, it could mean airborne transmitters and receivers assembled on a one-off basis by earnest amateurs or experimenters. Their handiwork would be reported in the press as having been installed and tested in flight, leading to uncertainty as to which planes were carrying what at any given time.

As a notable example, *Wireless Weekly* for October 28, 1932 carried a picture of two-way radio, custom built for a trans-Tasman flight scheduled for early 1933. Typical of hand-made 1920's-style equipment, housed in a stout wooden carrying case, it offered a power output in the range 10-50 watts, depending on the power source, and could transmit either voice or Morse Code.

It was to be installed in a special sound-proofed wireless cabin in the *Southern Cross*, and would feed a V-antenna strung between the wing tips and tail — ostensibly a foregone conclusion.

Yet a few weeks later on December 9, 1932, *Wireless Weekly* ran a follow-up story commenting on the continuing uncertainty surrounding the choice of wireless equiment for the *Southern Cross* and explaining that: 'several transmitters had been built in Australia for use on the trip, but none of them appeared to be what was wanted'.

WHEN I THINK BACK

It went on to picture a commercial receiver and transmitter which Philips in Holland had designed and produced for similar tri-motor Fokkers, flown by the KLM Air Mail Service. Described as 'the last word in radio for Smithy' and priced at £900, they were due on the *Narkunda* later in the month — December 29.

Also feeding a V-antenna atop the plane, the new Philips 10-watt transmitter was said to be crystal controlled, with back-up tuneable coverage between 25 and 90 metres. Special headgear for the crew carried in-built headphones and an optional microphone.

The equipment was purpose-built, of thoroughly professional appearance, and capable of remote control by means of Bowden cables (Fig.4). It was presumably used for what proved to be an uneventful flight on January 11, 1933, followed by a barnstorming tour of New Zealand.

Now for another up-date:

Beams for bombers

The 1928 forecast of 'invisible lighthouses in the sky' proved spot-on during WWII, when the Germans set up secret primary and intersecting beams ('Knicke- beins') to guide their nighttime bombers to strategic targets in the UK. We covered the story in the August 1992 issue.

The Brits suspected the existence of the Knickebein beams, but could not be sure because:

1. No such beams showed up on available British equipment.
2. Crashed German bombers did not appear to be fitted with any special receiver. (The Germans had cleverly adapted their Lorenz type blind landing receivers to perform the extra function).
3. The Germans had also installed steerable, high-gain, highly directional antenna arrays at key airbases, ostensibly as blind landing aids but able, in conjunction with a high power transmitter, to project very narrow beams across Britain.

As we explained in the abovementioned issue, the impasse caused all sorts of ructions in the British High Command, as recorded in the writings of various intelligence-based personnel.

It was due largely to prompting by service personnel with an amateur radio background, that a specially fitted British Anson bomber detected intersecting German guidance beams focussed above a Rolls Royce engine factory at Derby!

An Australian amateur, Mr K.G. England (VK1KGE), writes to say that, having perused much of the literature on the subject, it would seem to him that a prime reason for the Brits' inability to discern the intruding beams was the fact that the carriers were frequency rather than amplitude modulated.

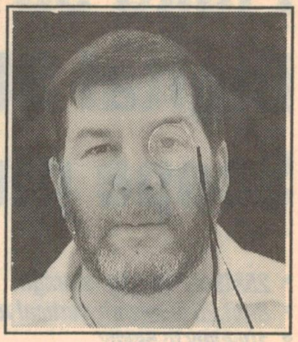
Unlike available British VHF receivers, which were limited to AM and CW, the imported US-made Hallicrafters receivers installed in the Ansons not only provided coverage from 27 to about 150MHz but were switchable to FM. He suggests that they were as advertised in the 1941 edition of the *ARRL Handbook* and priced at US$175. I quote:

A junior officer, who was an amateur, knew of several of these Hallicrafters sets in a London radio shop, so he went out and bought the whole stock. When installed in aircraft, the sets revealed how the navigation system then in use by the Axis worked.

The 1930's have been described as 'the golden years' of consumer radio. They were obviously very fertile years for avionics, as well! ❖

Moffat's Madhouse...

by TOM MOFFAT



The Phone Phreak Phenomenon

I have recently been reading a book called *Cyberpunk*. It is the definitive history of computer hacking, back in the days when it was considered a reputable sport (well, almost), instead of the vandalism it's thought of today. Hackers with names such as Pengo and RTM spent their leisure hours trying to penetrate the early computer networks, generally with a view to simply 'entering' a distant computer system. They weren't there to do harm, just 'enter', and possibly leave behind a calling card to prove that they had done so.

Much of this activity centred on prestigious universities such as Cornell and Dartmouth, in the northeastern United States. These universities ran innovative computer science faculties which encouraged learning by experiment, as well as by direct instruction. A badge of honour among students was to do something with a computer that had never been done before. This was known as 'hacking', and it went on with official sanction. Many a Master's thesis and Doctoral dissertation came about as a result of some creative hacking.

The people who became hacking legends did so by spreading their wings beyond the bounds of the university's computers, moving across the networks and into machines on the other side of the world. Unfortunately people like Pengo and RTM, once inside the remote machines, couldn't resist nicking the occasional bit of software or a military secret. They went to jail, their names were mud, and hacking became a Bad Word.

But the 'good' meaning of hacking still persists to this very day; it is given to something that is done in a new and remarkably simple way, breaking all the established rules. I must admit I was very flattered when one of my projects, the Wesat weather satellite decoder, was described as a 'neat hack' because of the way it decodes the signal without using a demodulator.

The Internet is the world's largest computer network, and the one that landed RTM in jail when his experiments to penetrate Internet computers went wrong. And on the Internet to this very day there are file areas labelled 'hacks', where you can expect to find the most innovative and unusual software.

Unfortunately my university days were a bit too early for hacking. Computer Science courses did not exist; in fact computers barely existed, and those that did were multi-million dollar mainframes attended by people who were basically mathematicians. Nobody had thought of tying computers together with networks, so there was really nothing to hack. That's a pity, because I probably would have been in it. Well, maybe in jail too. I suppose it's better there weren't networks....

Ah, but there were! They were called 'long-distance telephone networks' and they let people all over the country talk with each other. It was customary to pay a fee for this privilege, but early 'hackers' devoted much time and energy into avoiding the necessity to pay for long distance phone calls. This, as with computer hacking, was more for the sport than for financial gain. People who took part in this interesting activity were known as Phone Phreaks. Pengo and RTM started their hacking careers as Phone Phreaks. And I was certainly around during the Phone Phreak era — strictly as an observer, you understand...

The 'crony bar'

The first Phone Phreak device was not electronic at all, but a piece of coat hanger wire. This wire, known as a 'crony bar', had a small handle looped into one end, followed by a 90° bend to the left, and then a 90° bend straight up. The device was inserted into the coin return chute of a pay phone, and when jiggled correctly it would make coins inserted at the top come straight out through the bottom.

The crony bar, as I remember, was developed by students at the above-mentioned Dartmouth University. (Later on, they produced the BASIC computer language.) And, if memory serves me rightly, construction details were published in a magazine, which I think might have been *Playboy*. Crony bars were a boon to impoverished university students who needed to call home for more money.

Eventually the American Telephone Company had to develop a whole new model of pay phone, which was immune to the crony bar. These phones had a little pull-down gate on the coin return, which blocked the passage up into the phone when the gate was opened, preventing the entry of crony bars.

Infamous 'Blue Box'

With the demise of the crony bar a new line of attack was needed, and this time it was provided by electronics, via a gadget known as the 'Blue Box'. The Blue Box didn't just work on pay phones; it could force nearly any phone in the land to make free trunk calls, dialled up on an early 'numeric keypad' on the front of the box. I remember once seeing a photo of a Blue Box in a magazine — and sure enough, it was blue.

The Blue Box was publicised, but construction details were not. These were kept as 'secrets of the clan' by practicing Phone Phreaks; after all, they had to have something that made them stand out from the general public. But with a bit of knowledge of how the phone network operated back then, it wasn't hard to surmise how a Blue Box worked. Experiments proved the theory correct, and opened the way for a new Blue Box that didn't need any special electronics at all — only a tape recorder.

So now, 30 years too late, we now present full technical details of the Blue Box; enough information for you to build one for yourself. However you needn't bother, because it won't work on the Australian phone network. It appears the system isn't sensitive to the crucial 2600Hz 'SF' tone.

The American phone network, in the sixties at least, depended upon Dual Tone Multi-Frequency (DTMF) tones to dial numbers through the trunk network. These circuits could handle only audio, not DC, so dial pulses had to be converted to tones. The same went for on-

hook/off-hook information. This was transmitted as 'signal frequency' or SF.

Around this time, DTMF dialling was becoming popular in home phones as well; everyone wanted a push-button phone with 'Touch Tone'. These are all the rage nowadays too, and in Australia we are familiar with the sound of the beep-boops as we push the buttons on one of these phones. But in America, Touch Tone phones were incapable of dialling along the trunk network because the trunks used *different* tones, and these were supposed to be a closely-guarded secret.

'Secret' tones

When a subscriber wanted to dial a long-distance call he would punch in the number on his Touch Tone pad or rotary dial, and these tones or pulses were decoded and then re-transmitted along the trunks as 'secret' tones by equipment within the exchange. This process was supposed to be unknown to the subscriber, but many times you could hear a quick burst of new DTMF tones being shot along the network to the other end.

The 'secret' tones, however, soon became known. One source was the Howard Sams book *Reference Data For Radio Engineers*, where the scheme is detailed on page 2-13. For various operational reasons it is necessary to send numbers of varying lengths along trunk circuits, so the 'secret' scheme contains some extra signals: A 'KP' tone burst tells the system that some digits are to follow, and an 'ST' burst signals when they are finished.

Other tones signify the digits 1-10. Each signal is made up of a pair of frequencies, as described below:

Digit	Frequencies (Hz)
KP	1100 + 1700
1	700 + 900
2	700 + 1100
3	900 + 1100
4	700 + 1300
5	900 + 1300
6	1100 + 1300
7	700 + 1500
8	900 + 1500
9	1100 + 1500
0	1300 + 1500
ST	1500 + 1700

The only other tone to mention is the 'SF' signal-frequency tone, which is 2600Hz. The presence of SF means the circuit is 'on-hook', and its absence means 'off-hook'.

When dialling is to take place, the originating end kills the SF tone, telling the far end that its 'phone' is off-hook. The far end responds with a high-level blip of SF, called a 'sender', and then continues sending normal-level SF as the number is dialled. If the far end answers, it is off-hook and the SF from there is killed. Then there are no tones on the circuit, and a conversation can take place.

The most interesting feature of this, from a Phone Phreaking point of view, is that either end can force the other end to hang up by hitting it with a blast of SF tone. This of course happens when either party hangs up (goes on-hook). But you can also cause the far end to go on-hook, without you yourself actually hanging up, by playing a 2600Hz SF tone into your telephone's mouthpiece. This is the Phirst step of a Phone Phreak session...

Upon hearing the SF, the far end goes on-hook. But if you now kill your SF again, the far end responds with a new 'sender', and it is ready to receive another number. Now you put your Blue Box up near the mouthpiece, punch KP, punch in the number, and then punch ST. Your new call is away! But your phone is still physically 'off the hook', and the exchange thinks you are still connected with your original call.

Of course it is necessary to get into the trunk network in the first place for Phone Phreaking to work, but this is simply a matter of making a trunk call. For this, of course, you will be charged. But there are such things as FREE trunk calls, like when you ring the time and the talking clock is physically in a different city. You can stay on the talking clock as long as you like for the price of a local call, making one Phone Phreak call after another.

One can avoid the necessity of a proper Blue Box by using two audio oscillators and a reel-to-reel tape recorder. You simply set up the oscillators to produce the correct two tones, combine them through a simple resistive divider, and record two or three minutes of each tone combination.

Before making a call you must get your scissors and sticky-tape and edit together the correct sequence of SF, KP, the numbers, and ST, and then play the resulting tape into the telephone.

This sounds like an awful lot of trouble, but it produces the desired effect. You succeed in beating the system. The biggest problem for Phone Phreaks is trying to think of someone to ring. Once you've cracked the network all the fun is gone out of it.

Many Phone Phreaks demonstrate their skills by ringing distant recorded services; for instance 617-536-4050 gives you (or used to give you) a recording of the activities of the bird watching society in Boston. In New York you could try 212-759-1520 to get a recording from a bedding shop, designed to put you to sleep. In San Francisco, 415-LOSTDOG gave a list of — you guessed it! Really keen Phone Phreaks rang the White House, or the Kremlin.

It's very doubtful any of this stuff still works, although one never knows in the USA where the telephone company has been known to squeeze 40 years life out of a piece of central office equipment. As I mentioned earlier, it does NOT work in Australia, and you may well bring down the wrath of Telecom upon your shoulders should you get caught squirting strange tones down the line.

In the USA, Phone Phreaks face new challenges from the computer technology taking over the phone network. I have read that Ma Bell over there has even developed Phone Phreak detectors, which can pinpoint any new Blue Box designs and send the cops running.

Despite the dangers, or perhaps because of them, I see from things I've picked up on computer bulletin boards that Phone Phreaking is still alive and well in the USA. But now, like so many other activities, it's a crime that can send you to prison and screw up your life good and proper. Best avoid it now, I guess. Get yourself a copy of *Cyberpunk* instead. ❖

THE SERVICEMAN

Special VCR servicing tools: a look at the Tentel range of gauges...

This month I'm departing from my usual line of discussion, to talk about the tools we use in our day to day work. In particular, I've been testing out some of the Tentel range of VCR servicing tools, and what follows is largely a summary of what I've found, both on my own bench and when I took them to some colleagues' workshops.

When I first started servicing electronic equipment, my only tools were a screwdriver and a soldering iron. It was actually several months before I could afford to buy a multimeter!

That was back in the days of five-valve mantel radios, and a simple multimeter was the most complex tool needed to repair the usual run of faults.

Later, when I got more involved with audio and tape recording, I added a simple audio generator and an equally simple oscilloscope to my inventory. (That scope was the top instrument of its day, but had a bandwidth of only 50 kilohertz!)

Time passed and television came to entertain us. In the beginning, I had no need for more than my radio and audio tools. Only the rare, very difficult job called for more sophisticated test gear, and most of us just muddled through without it.

The crunch: CTV

The crunch came with colour TV. The old 50kHz CRO was simply no use on a colour set. A new 15MHz CRO was a huge investment at the time, and was followed soon after by more big dollars for a colour bar generator.

That was in 1975/76, and the expense of those two purchases nearly broke me. It took years to pay them off. But those tools are still in use in my workshop today and are still doing the job they were purchased to do. (So spread over nearly 20 years, they didn't really cost so much after all!)

VCRs arrive

Then sometime around the mid-eighties, the first video cassette recorder found its way into my workshop. I can't recall what the fault was, but it must have been something simple, since I fixed it with whatever tools I had on hand.

As more and more VCRs followed, it became evident that another purchase of specialised tools was going to become inevitable. The difficulty was going to be, which tools to buy?

If you remember, at that time it was touch and go as to which or both video formats were going to capture the market. Beta was presenting the best pictures, but most rental tapes were VHS. For a time it looked as though I was going to need two of everything — Beta *and* VHS.

As time passed it became clear that I, at least, need only worry about VHS machines.

For some odd reason I have only ever had three Beta machines brought to me for service. I am so unfamiliar with the format that I take them straight off to a colleague and get on with servicing my VHS customers.

The problem with tools was that although VHS machines were all supposed to be standardised, each manufacturer chose his own route to the standard — so that different jigs and gauges were needed to service each brand.

Then the manufacturers chose to release new models, and these needed a whole new set of jigs. And since the various jigs and gauges cost a hundred or more dollars each, the total value of a desirable inventory soon became prohibitive.

Note that term 'desirable inventory'. In fact, a lot of these specialised tools are only needed for the most difficult or obscure repairs. It was a question of how often they would be needed versus the benefit of having the necessary tool right on hand.

As a result, most servicemen that I know bought only the most essential VCR tools, and then learned the 'eyeball technique' for other adjustments and repairs. So in most workshops you'll find a 'back tension gauge' and an 'alignment tape'. And not much else, apart from the items which also find a place in colour TV servicing.

In each workshop that I know of, wherever one of these special tools has been purchased for a particular job, it was later pressed into service in a maintenance role, to confirm that other similar machines are within specifications. In other words, while it may not have been economical to buy the tool just for maintenance testing, once having got the tool for a special purpose, it was not allowed to lie about unused until the next 'special purpose'.

As a result, the initial purchase price can be spread over a wide range of different jobs — thus reducing the 'cost per job' to an insignificant amount. Just like my 20 year old CRO!

Three of the new Tentel VCR servicing tools. At front left is the TQ-600 torque gauge, while at centre rear is the Tentelometer tape tension gauge. At lower right is the Reel Table Height gauge, which effectively replaces all of the 'master plane' tools previously needed in servicing the many models of VCRs.

Down to business

All of this cogitation on tools and and the cost of same came about after the Editor asked me to review a new range of video recorder service equipment.

It seems that Tentel Inc, a US-based manufacturer of test equipment, looked at the myriad of VHS, Beta and Umatic test tools and jigs and came up with the idea of making a few universal tools that could replace the hundreds of specialised pieces called for by the video manufacturers. The new range is now being imported by a Queensland company, and is now available to the Australian service industry from a local source.

The Tentel range consists of four basic test instruments, with several associated accessories.

Reel Table Height Gauge

For most VCR manufacturers, there is a tool known as a Master Plane — basically a heavy steel plate with holes in it. The purpose is to provide a reference level from which the height of the reel tables and entry and exit guides can be checked. These measurements are vital to the proper handling of the tape, and maladjustment can lead to severe tape damage.

As is the wont of most manufacturers, their Master Plane is usually different to everyone else's, and often different to their own model last month (well, last year!). So any device that could replace 50 or more master planes must be a benefit. The Tentel Reel Table Height Gauge is such an instrument.

It is a heavy metal base plate with end pieces to approximate the size of a cassette. Mounted over each reel table cutout is a micro-sensitive dial gauge, reading in 1/20mm and 1/1000".

When the gauge is loaded into the cassette carrier and lowered into the operating position, the dial actuating levers ride on the edges of the reel tables and so indicate their height relative to the cassette carrier. In a well-adjusted machine, both dials should read zero; but a small plus or minus tolerance is allowable.

The gauge will also indicate the 'trueness' of the cassette carrier. If the two dials give significantly different readings, it's a sign that the carrier is out of true and not holding the cassette in its correct position.

There's another test which can be effected with the Tentel gauge, one that is not possible with a conventional Master Plane. It's a test of the latching accuracy of the cassette carrier. When the carrier is in position, it should be held firmly without any up and down play. The dials can indicate any looseness in the latch as pressure is applied with the fingers to the centre of the gauge.

The real benefit of the Tentel 'Master Plane' Gauge is that it is used with the cassette carrier in place. Other master planes require the carrier to be removed before they can be used. All that is necessary with the Tentel gauge is a sufficient gap in the top of the carrier to enable the user to see the dials below.

We found only one problem with the Tentel Master Plane Gauge. It's a bit thinner than a standard cassette and the carrier doesn't grip it so tightly. This is no problem with machines which eject slowly, but we found one machine which flung the gauge out onto the floor.

It suffered no damage on that occasion, but after that we were very careful to put a hand in front of every machine as we ejected the gauge...

The Tentelometer

One of the more important tape handling measurements is that of tape tension. If the tension is too high, it leads to premature head wear and tape damage. If too low, the penalty is poor quality pictures and again, tape damage.

The usual instrument for testing tape tension is the so-called 'back tension gauge'. This comprises a spring gauge fitted into a standard cassette housing. It's loaded into the machine and 'played' in the usual way. The amount of 'pull' exerted on the tape represents the tension and is indicated on the scale visible through the cassette window.

There is one major problem with this type of gauge: it only indicates tape tension at one diameter of tape pack — somewhere around the middle of a

'standard' cassette, whatever that is. It is possible, even likely, that the tension would be significantly different near the beginning of a three-hour tape, and also near the end of the same tape. It's a function of the diameter of the tape on the reel.

The Tentelometer makes it quick and easy to measure tape tension anywhere in the tape path, and at any diameter of tape pack.

This instrument has been around for many years, but has not been seen in domestic service to any great extent. It comprises a dial gauge with three probes extending from its base. The middle probe is slightly offset from the other two and as the tape is passed between them, it attempts to push the probes further apart. This tiny effort is magnified by the gauge and displayed on the dial, calibrated in grams/centimetres or ounce/inches.

As mentioned, the tape tension reading needs to be taken at three places along a three hour tape, to accommodate an expanding reel diameter. This would normally involve several minutes of fast- forwarding through the tape. Tentel have come up with an ingenious accessory to the Tentelometer to vastly speed up this process.

This is their Tension Evaluation Servo Test Cassette. It varies from an ordinary cassette only in its take-up reel. Two plastic pins have been added to the spool, near the outer edge, so that the tape winds in an eccentric manner. For each revolution of the reel, the tape diameter varies from maximum to minimum and the Tentelometer can thus display the varying tape tensions in a matter of seconds.

As mentioned, the Tentelometer has been around for quite a few years. One of my ex-TV station engineer colleagues told me that they had been using it on Betacam, BVU and one-inch machines for something like 10 years. At that time its cost was prohibitive for anyone but the professional user. Today the question is, can any well equipped workshop afford *not* to have a Tentelometer?

The Torque Gauge

The torque applied by the takeup and supply reels is an important parameter in VCR service. In effect, it determines the tape tension and therefore the amount of pressure applied to the delicate video heads.

Ideally, the torque should be the same throughout the length of the tape. But since torque is the product of tension and radius, and since the reel motor tries to drive the reels at a constant speed, it's apparent that the reel torque must vary from end to end of the tape.

Short of powering the reel motors with variable speed drives, and arranging a servo loop to monitor tape tension, all that can be done is to ensure that the reels are applying an appropriate range of torque. Not so much that it could stretch the tape, nor so little that the video heads loose contact with the tape.

The most common type of torque gauge used in VCR servicing is the short, stumpy dial gauge. Some are fitted with a plastic extension to adapt them to the reel table. Others rely on simple friction to engage the mechanism.

But although these gauges might be called universal, in that they can be used on any type of VCR, the main characteristic of this type of gauge is that the cassette carrier has to be removed to allow access to the reel tables.

Tentel has come up with a completely new type of torque gauge that is truly universal and does not need the VCR to be dismantled before use.

The Tentel Dial Torque Gauge consists of a two-piece shaft, about 200mm long. A fixed 100mm dial calibrated from 0 to plus and minus 600gm-cm is attached to the lower unit. The upper part of the shaft is connected by a springy torsion bar and carries the dial pointer.

The thin lower shaft can easily pass through the gaps in almost any cassette housing, so that readings can be taken with everything in place. For those VHS machines that will not run without a cassette in position, a cutaway cassette is provided with the kit.

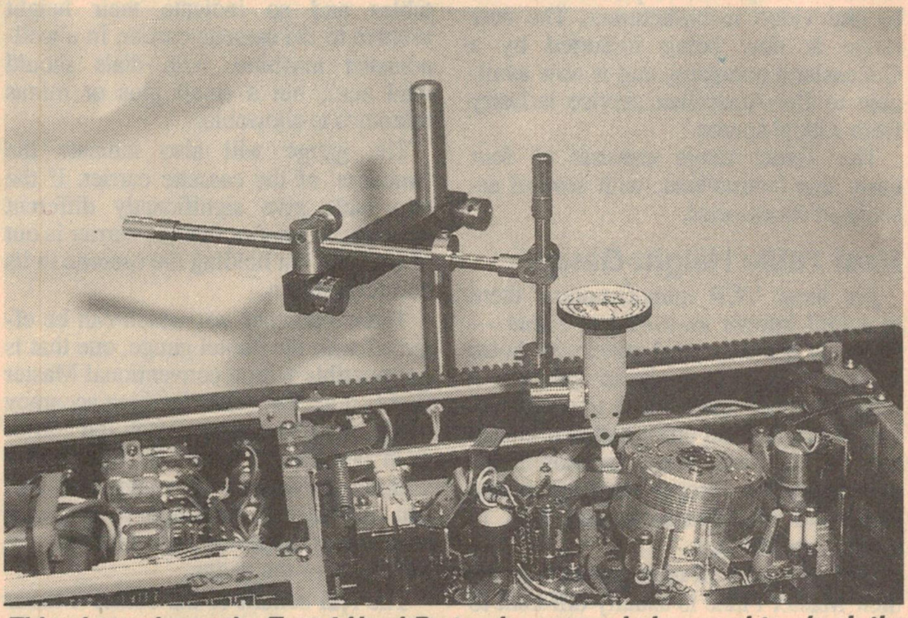
We had one or two minor quibbles about the Tentel Torque Gauge. One was that since the dial is marked 600/0/600gm-cm in units of 25, it was a little difficult to measure small forces such as 30 - 40gm-cm. Then we found some machines that delivered considerably more than 600gm-cm in rewind mode.

We started with a firm grip on the gauge and had it wrenched out of our fingers when the machine took off. The dial carries a very effective stop so it suffered no damage from this exercise, but it was still a bit disconcerting, nevertheless.

Overall, we found the Tentel Dial Torque Gauge to be a versatile, robust and easy to use tool. It seems to be quite accurate enough for the servicing it is designed for, and could be recommended for use in any workshop.

Head Protrusion Gauge

At first glance, when I saw the Tentel 'Eccentricity and Head Protrusion Gauge' I wondered what was *eccentric* enough to warrant a gauge like this one. Then I remembered that replacing the video heads in a Beta machine was not the straightforward process that it is in



This photo shows the Tentel Head Protrusion gauge being used to check the heads on a VHS recorder's drum. The supporting rod system has built-in micrometer adjustments, making precise positioning very fast and easy.

VHS. As I understand it, new heads are fitted to Beta machines with some degree of looseness. They must then be centered accurately with a sensitive gauge of one kind or another before being tightened down.

Most workshops that do (or have done) a lot of Beta machines have invested in a suitable dial gauge and the appropriate mounting blocks. This is another example of multiple tools to do a single job. In fact, although the dial gauge can be used on any machine, each model has its own mounting block and it's impossible to use the gauge if you don't have the appropriate block.

This is another of those situations that encouraged the Tentel company to devise a universal mount — one that would suit any and all VCRs. What they have come up with is likely to be the most useful tool in any workshop that services Beta machines, or any of a range of professional equipment.

The Tentel mount can also be used to measure head protrusion, the distance by which the video head protrudes beyond the face of the head drum. This is a useful measure of head wear and can be used to determine whether or not an old machine is worth repairing.

The Tentel Eccentricity And Head Protrusion Gauge (TEAHPG for short) is more of a universal instrument stand than a gauge in itself. As mentioned, many workshops already have an appropriate dial gauge. The difference is that this assembly will work with any machine — Beta, VHS, video 8, and all the professional formats BVU, Betacam, etc.

It comprises a V-shaped base on which the machine under test is placed. A vertical rod is screwed into the apex of the V and an adjustable arm is fitted on this rod. Then comes the truly innovative part of the system. Each of the two tubular arms that support the dial gauge can be roughly adjusted by screw clamps. But *inside* each arm is a micrometer adjustment which allows very precise positioning of the gauge sensor tip.

The whole assembly allows unlimited adjustment to any angle in any direction. It totally negates the need for the unique mounting blocks mentioned earlier.

I showed the TEAHPG to one of my colleagues, while he was working on a Betacam for a local TV station. He had the TEAHPG set up within two or three minutes, and in no time at all had completed all the checks and measurements needed to confirm the proper operation of the camera.

He was very enthusiastic about the device and rather annoyed that he had not long since invested in yet another mounting block for his (conventional) dial gauge.

Summarising...

If you have got the idea that I am excited and enthusiastic about this new range of VCR test equipment, you're right. I am, and for the very good reason that it's versatile, accurate enough for the work we do, and it replaces dozens of dedicated tools that, in total, cost the earth.

I road-tested the gear for a couple of weeks in my workshop, then took it to the shops of friends and colleagues to see what they thought of it. In general, there were two responses.

One was "I wish this had been available before I spent so much on this and this and this!" The other response was "It's great, but do I really need it?"

The first respondent had recognised the need for good tools and had made the investment, only to find when I arrived that equally good tools were available for less money. The second respondent is one of those who had made the minumum investment in tools, but relies on animal cunning to solve problems that proper tools would have made a breeze.

For myself, I think that the torque gauge and the tension meter are so far ahead of the opposition that it's just no race. These tools are essential to anyone working with VCRs, and the Tentel tools are as good as any I've seen. I hope to add them to my range of tools very soon.

The master plane and the eccentricity gauge are really first class tools and are universal in their application. I'd have one of each straight away, except that the information they supply is probably not so important to servicing domestic machines and the investment might be better placed on other tools.

But then again, if I were just setting up my first workshop, I think I'd mortgage my first year's salary to kit myself out with the full range of these Tentel tools. They are robust enough to withstand a lifetime of service, and they could answer so many questions so quickly that they would have no trouble earning their keep in just a year or two.

I think Tentel have come up with a winner, and the local importers deserve every credit for stocking the product.

What about price?

All right — I wasn't going to mention price, but just give you the name and address of the importer. After all, this is not an advertising column. But since everybody I've spoken to wants to know the prices, I feel that this information is a legitimate part of my review. So here goes.

The current prices, in Australian dollars, as at 7/10/93 are as follows:

Master Plane (TSH-V5)	$930.90
Tentelometer (T2-H7-UM)	$739.50
Torque Gauge (TQ-600)	$565.50
Eccentricity/Head Protrusion Gauge (HPG-1)	$1383.30
Tension Test Tape (TT2)	$69.60

All of these prices are subject to 21% sales tax, if applicable. The distributors offer a 15% discount before tax if two or more gauges are purchased at the same time. (Remember that currency rates are changing all the time and these prices have recently been increased to reflect that situation. When the exchange rate improves, the prices can be expected to fall.)

When I gave these prices to one of my friends, his response was "Gulp!", then "Thanks, but no thanks!"

At first glance they do look rather steep. But look again, and consider the tension gauge, T2-H7-UM at just under $900 including tax. The nearest equivalent to this is a German-made back tension gauge, currently listed at just on $400 including tax.

The German gauge is housed in a modified VHS cassette and can only be used in VHS machines. The Tentelometer is a universal instrument that can be used in any type of video recorder — VHS, Beta or U-matic. If back tension gauges for the last two machines were of similar price to the VHS model, then the Tentelometer looks a bargain at three quarters of the price.

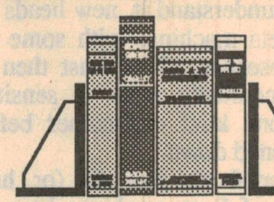
Similarly, the master plane gauge fits all full sized VHS machines for $930. Compare this with around $100 each for dedicated gauges for each make and model. And as well, the Tentel instrument can perform other tests that a conventional gauge can't do.

As I said earlier, it would be hard to justify this expense if you already had a range of similar tools. But if you were considering an original purchase, then the Tentel range must be the way to go.

The Tentel range of video service tools is available from MUSICLAB Pty Ltd, 288 Abbotsford Road, Albion, Qld. 4010. Their phone number is (07) 862 1633, and fax number (07) 862 1578.

That's all I have space for this month. Next time we'll be back to using tools, rather than talking about them. ❖

NEW BOOKS



Laser disc players

LENK'S LASER HANDBOOK, by John D. Lenk. Published by Tab Books/McGraw-Hill, 1992. Soft covers, 228 x 152mm, 17mm thick (page numbers not cumulative). ISBN 0-8306-4429-6. Australian RRP $47.95.

This is a book intended primarily for the service technician, to provide them with the information necessary to repair CD players, laserdisc players and similar equipment using laser-based optical pick-ups. US-based author John Lenk is very well known for his technical books, with some 72 titles to his credit — many of them in the area of TV and video servicing.

Despite the emphasis on servicing, though, it does cover a lot of the basics of player operation, and also goes into considerable detail regarding the circuitry in the various subsections. This should make it of considerable interest and value to both students and the general electronics reader who wants to know more about this equipment and its operation. The coverage is mainly of audio CD and video laserdisc players (including CD-V players), but there's also some useful information on CD-ROM players.

The discussion of video circuitry centres on the American NTSC system, with very little about PAL. But despite this my impression is that a great deal of the 'nitty gritty' servicing information would be just as useful out here — including most of the material dealing with mechanical troubleshooting and adjustments.

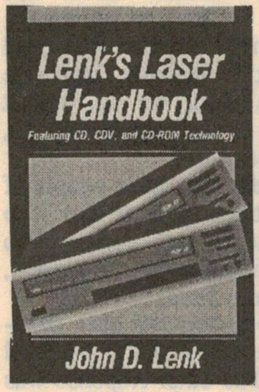
In short, quite a good source of information on this otherwise rather poorly covered area of consumer electronics.

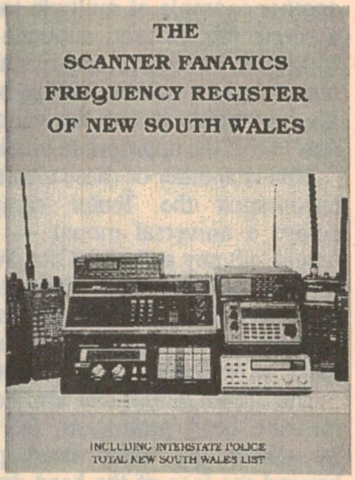
The review copy came from McGraw-Hill Australia, of 4 Barcoo Street, Roseville 2069; phone (02) 417 4288. However copies should be available at all larger and technical bookstores. (J.R.)

Multimedia primer

WELCOME TO MULTIMEDIA, by Linda Tway. Published by MIS Press/Henry Holt, 1992. Soft covers, 236 x 182mm, 322 pages. Includes demo CD-ROM. ISBN 1-55828-242-4. Australian RRP $49.95.

The transformation of personal computers into 'multimedia systems' is now





well and truly under way, with the latest model PCs already being fitted out with CD-ROM drives and sound cards. There's also a plethora of MM conversion packages, sound cards and CD-ROM drives being offered for upgrading of existing machines, and many software outlets are now offering a modest number of CD-based games and other packages. Unless I'm seriously mistaken, this exciting field is going to expand and develop dramatically in the coming year, so we all need to learn more about it.

The author of this book, Dr Tway, is well equipped to produce an introduction to the subject. She has a doctorate in Interdisciplinary Sciences, and has been heavily involved in MM training and application system development, for a couple of years. In fact she runs a company specialising in this very area.

She seems to have provided an excellent basic introduction to the subject, for those with little or no initial knowledge. It covers basic concepts, hardware and software requirements, assembling a system, and the basic techniques of building a sample MM project. In this latter section it uses for illustration the *Windows 3.1*-based MM authoring package *Multimedia ToolBook*, from Asymetrix Corporation, which has been used to produce many of the commercial MM packages (including *Multimedia Beethoven: The Ninth Symphony*). A demo version of *ToolBook* is provided on the CD-ROM which comes with the book, with sample application files and sufficient functionality to allow you to try most of the examples for yourself. (If you don't have a CD-ROM drive at present, there's a voucher to exchange it for floppies.)

From a quick run through both book and software, I'm very impressed. For more details on much of the MM hardware and software, you'll need to refer to other books and articles; but as a basic introduction, it's excellent.

The review copy came from distributor Woodslane, of PO Box 935, Mona Vale 2103; phone (02) 979 5944. But I've also seen copies in many of the larger bookstores. (J.R.)

Scanner guide

THE SCANNER FANATICS FREQUENCY REGISTER OF NEW SOUTH WALES/VICTORIA/WESTERN AUSTRALIA/TASMANIA/QUEENSLAND/SOUTH AUSTRALIA, printed by Tamara Graphics & Printing, 1992. Soft cover, 298 x 208mm, 77 pages (NSW Edition). Recommended retail price $24.95 and $19.95.

The main content in each of these six books is a list of users of the various frequencies within the specified state. The frequencies listed only cover users operating at 5W or more, within the range from 35MHz to 900MHz. For NSW this range is extended to 30 - 1300MHz, and for Victoria from 30 - 900MHz.

(Continued on page 103)

ROD IRVING ELECTRONICS ROD IRVING ELECTRONICS ROD IRVING ELECTRONICS

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1.44 Mb 3½" F.D.D.	$79.00
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3½" F.D.D. CRADLE	$9.95

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2 WAY DB25 PIN..............$29.95
4 WAY DB25 PIN..............$39.95
2 WAY CENTRONICS........$34.95
4 WAY CENTRONICS........$49.95

HARD DRIVES

VOICE COIL IDE HARD DRIVES

Cap	Av.Access	Tax Inc.	Tax Ex.
131M	16ms	$349	$288
212M	16ms	$379	$310
260M	16ms	$459	$379
345M	12ms	$569	$469
420M	12ms	$789	$651
540M	12ms	$999	$830

MOTHERBOARDS

386SX-41 LM 47 32K Cache.............$169
386DX-40 128K Cache.......................$249
NEW 386DX-40 128K Cache & Upgradeable CPU socket and Local Bus Slot.$369
486DX-33 256K Cache with upgradeable CPU socket and 2 Local Bus Slot......$795
486DX-50 256K Cache L.B...............$1195
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486-50 EISA...................................$1795
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MULTIMEDIA PRODUCTS

SOUND BLASTER DELUXE.... $99
SOUND BLASTER PRO........... $199
SOUND BLASTER 16 BIT ASP $449
MIDI BLASTER.......................... $385
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VIDEO BLASTER....................... $649
SPEAKERS TO SUIT, ONLY....$10

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5 CD's, S'Blaster 16, Dual Speed CD ROM, Speakers, Microphone, VRS.

PREMIUM PACK $1099
8 CD's, S'Blaster 16, Dual Speed CD ROM, Speakers, Mic, Voice Assist.

DISCOVERY PACK.................. $699
4 CD's, S'Blaster Pro V2, Dual Speed CD ROM, Speakers.

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EPL 5200 $1299.00
*Laser *6p.p.m. *300 dpi
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STYLUS 800 $599.00
Epsons new ink jet technology delivers 360 x 360 dpi text and graphics * 9 standard fonts
* 48-nozzle ink jet dot matrix
* 180 cps LQ (12cpi)
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Super I/O Card.................................$120
1 Meg VGA Western Digital............ $199
1 Meg VGA Oak.............................. $129
Cirrus Logic 1 Meg......................... $149
Parradise Accelerator LB............... $355

16 BIT CARDS

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Turbo Accelerator (Paradise).........$185
Cirrus S3 VGA...................................$199
1 Meg Trident 8900CL $199
IDE Paddle and SPG cards............ $49

8 BIT CARDS

2 Port serial card............................$39
Clock card..$29
Game Card.......................................$29
2 Way F.D.D. controller..................$49
Ethernet (NE1000)..........................$235

STUDENT SOFTWARE

WINDOWS BASED STUDENT SOFTWARE

	STUDENT	FULL
Lotus 123 V4	$179	$580
Lotus Freelance V2	$179	$580
MS Powerpoint	$230	$595
MS Project	$340	$880
MS Publisher	$110	$295
MS Works	$99	$250
Norton Back-up	$99	$250
Norton Desktop	$155	$250
Quattro Pro V1	$99	$550
WordPerfect 5.2	$189	$525

STUDENT IDENTIFICATION MUST BE PRODUCED WHEN ORDERING AT THE STUDENT PRICE

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PLASTIC BOXES

Description	1-9	10+
3½ DS/DD	$18.95	$17.95
3½ DS/HD	$28.95	$26.95
5¼ DS/DD	$13.95	$12.95
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CARDBOARD BOXES

Description	1-9	10+
3½ DS/DD	$17.95	$16.95
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5¼ DS/DD	$12.95	$11.95
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DESCRIPTION	1-9	25+	100+
1M x 9-60	$99	$95	$89
1M x 9-70	$85	$83	$79
4M x 9-70	$299	$295	$289
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FREE 148 PAGE CATALOGUE
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MAESTRO MODEMS

96M (ext) 9,600 baud, error correction, data compression
X19007.......................................$499
144M (ext) 14,400 baud, error correction, data compression
X19002.......................................$549

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RC224FM (internal) Card modem 2,400 baud data - 9,600 baud (send only) Fax.
X18990.......................................$249
9600XR (ext) 2,400 baud data - 9,600 baud send / receive Fax.
X19008.......................................$399
96FM (ext) 9,600 baud data - 9,600 baud send / receive Fax.
X18996.......................................$549
144FM (ext) 14,400 baud data - 14,400 baud send / receive Fax.
X19005.......................................$599
.All modems contain Quicklink II software. Fax Modems also contain Quicklink II fax software.

SCANNERS

GENIUS SCANNER 4500
Black, white and grey emulation scanner with powerful photo / image editor and multilingual omnifont OCR. $199.00
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24-Bit True colour 800-DPI Hand Held Scanner. Gives Images a rainbow of 16.8 million colours
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COME INTO OUR CITY STORE FOR A FREE DEMONSTRATION OF THESE SCANNERS DAILY AT 12.30pm, & 1.30pm,

BOX HILL STORE NOW OPEN 9 - 3P.M SATURDAY.

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DESCRIPTION	1-9	10+	50+	100+	500+
5¼ DS/DD	$4.75	$4.50	$4.50	$4.20	$4.20
5¼ DS/HD	$8.50	$7.95	$7.90	$6.90	$6.90
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All disks come with Write Protects and envelopes and a life time warranty.

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540M HARD DRIVE JUST $999.

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USE YOUR LOGIC & SAVE "MULTI" DOLLARS ON MULTIMETERS & LOGIC PROBES

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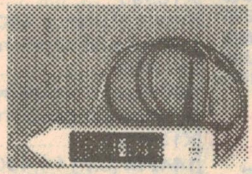
HUGE MULTIMETER SALE

SPECIAL OFFER

Buy two or more multimeters and receive an extra 10% off the price! But Hurry stock is very limited.

Please have a second choice handy in case your first choice is unavailable.

SAVE $15



LOGIC PROBE (LP-2800)

Useful for TTL and CMOS

High & low indicators pulse memory. For the hobbiest or serious technician for tracing those hard to find faults on logic boards

Q11272 Was $29.95

Sale price $14.95

SAVE ON BREADBOARDS

100 HOLES

P11000 Was ~~$3.95~~ Sale Price $2.75

PROJECT BREAD BOARD

- 58-Group of 5 connected terminals
- 4-Bus of 25 connected Terminals

P11002 Was ~~$6.95~~ Sale Price $4.85

640 HOLES

P11005 Was ~~$10.95~~ Sale Price $7.65

640 + 100 HOLES

P11007 Was ~~$13.95~~ Sale Price $9.75

640 + 200 HOLES

P11009 Was ~~$15.95~~ Sale Price $10.70

1280 +100 HOLES

P11010 ~~$26.95~~ Sale Price $18.95

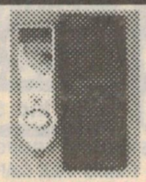
1280 + 300 HOLES

P11011 Was ~~29.95~~ Sale Price $21.00

1920 + 500 HOLES

P11015 Was ~~$59.95~~ Sale Price $41.95

SAVE $10



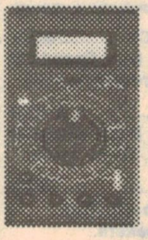
HUNG CHANG DIGITAL MULTIMETER HC-31

- Custom designed 80-pin LSI chip to achieve a low overall component count ensuring long term stability and accuracy.
- New LCD display with annunciators for functions, unit polarity, decimal and low battery.
- Rotary pencil type.
- Auto ranging and auto polarity.
- Convenient one hand operation by connecting the alligator clip.
- Measurement ranges (DCV,ACV resistance and continuity check, diode check).
- Data hold switch to fix he reading.

Q11270 was $49.95

Sale Price $39.95

SAVE $50



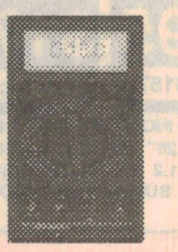
DIGITAL MULTIMETER HC-5010EC

- Display: 3½ digit
- Basic accuracy: 0.5% DC
- DC Voltage: 0-1000 Volts
- DC Current: 0-10A
- AC Voltage: 0-750 Volts
- AC Current: 0-10A
- Resistance: 0-20-M OHMS
- Capacitance: 0-20u
- Transistor: hfe gain Oof - 2000 oF
- Continuity Test, Diode test

Q13010 Was $149.00

Sale Price $99.95

SAVE $30



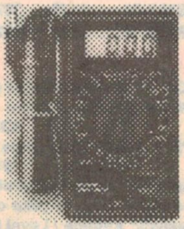
DIGITAL MULTIMETER HC-4510

- Display: 4 ½ digit
- Basic Accuracy: 0.5% DC V
- DC voltage 1-1000V
- DC Current: 0-10A
- AC Voltage 0-750V
- AC Current: 0-10A
- Resistance: 020M ohms
- Continuity Test, Diode Test, Data Hold

Q13030 Was $149.00

Sale price: $119.00

SAVE $20



HUNG CHANG MULTI-TESTER DM301

- 3½ Digit, Basic accuracy DMM
- Low Cost, Amazing Quality, Vane pocket size.
- Safety Designed-Compiled to UL1244, VDE 0411
- Overload protection
- Diode check

SPECS:

Display: 3 ½ digit LCD. 0.5 height with polarity.
Over range Indication: 3 least significant digits blanked.
Maximum Common mode Voltage: 500V peak
Operating environment: 0 to 50° C
Power: 9V alkaline or carbon zinc cells
Dimensions: 128mm x 75 x 24mm

Q13050 Was $49.95

Sale Price: $29.95

GRAB BAGS & VALUE PACKS

$10.00 GRAB BAGS

These grab bags contain a range of components and parts from old kits, including wire and LED's ceramic trimpots from the Service Dept. and old IC's, odd fuses crystals and tantalums.

$20.00 MONSTER BAG

Same components as listed above but heaps more and more value.

ASSORTED VALUE PACKS

.25W 1% METAL FILM PACK
Contains: Approx. 250
R19001........................$7.95

.25W CARBON FILM PACK
Contains Approx: 250
R19010........................$5.95

50V CERAMIC PACK
Contains Approx. 100
R19020........................$6.95

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Contains Approx. 50
R19030........................$6.25

PBC ELECTRO PACK
Contains: Approx: 50
R19040........................$6.95

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100 per pack

1N4002 (1A 200V Recifier)
Z10103........................$4.95

1N4004 (1A 400V Rectifier)
Z10106........................$5.95

1N4007 (1A 1000V Rectifier)
Z10112........................$6.95

1N914 / 1N4148
Z10135........................$3.95

1N5404 (3Amp 400V)
Z10114........................$12.95

LED MIXED PACKS
(Red only 5mm)
Approx. 100 pieces
Z10138........................$11.95

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3AG pack of 40 ($12 Value)
Contains: 4 x 500mA
8 x 1A, 6 x 1.5A, 2 x 2A, 6 x 3A, 4 x 5A, 2 x 7.5A, 4 x 10A.
S15992........................$8.95

M205 Pack of 40 ($12 Value)
Contains: 5 x 500mA, 10 x 1A, 10 x 2A, 5 x 3A, 5 x 5A, 5 x 10A,
S15994........................$8.95

MIXED IC SOCKETS
100 Units ($37.00 Value)
Contains: 15 x 8 pin, 20 x 14 pin, 10 x 16 pin, 10 x 18 pin, 5 x 20 pin, 10 x 22 pin, 5 x 24 pin, 5 x 28 pin, 10 x 40 pin,
P10546........................$24.95

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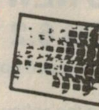
SAVE! SAVE! SAVE! HUGE SUMMER SOLAR SALE SAVE! SAVE! SAVE!

SOLAR PANELS

SAVE $20

9 Watt Solar Panel
Size: 370 x 370 x 17mm
• 12V Voc 16V (max) 18V
Isc 400mA (ax) 500mA
Z19028...Was ~~$99~~
Now Just $79.00

SAVE $30



18 Watt Solar Panel
12V Voc 16V (max) 18V
Isc 800mA (max) 1000mA
Z19036...Was ~~$199~~
Now Just $169.00

SAVE $70

27 Watt Solar Panel
12V 16V (max) 18V
Isc 1200mA (max)
1500mA
Z19038.....Was ~~$299~~
Now Just $229.00

SOLAR CELLS

ENCAPSULATED SOLAR CELL MODULE 0.45V 200mA
Z19001 Was ~~$2.95~~
Now Just $1.95

SAVE $5

SOLAR PANEL 3, 6, 9 VOLT
Simple and easy to use, this solar panel converts the sun's energy to electrical power supply of 3, 4.5, 6 and 9 volts for different electrical appliances. An ideal & conveinient power supply for powering small calculators, radios battery operated toys etc. This product also doubles as a battery charger for "AA" size rechargable batteries
Z19013 Was ~~$24.95~~
Now Just 19.95

SOLAR PANEL WITH MULTIPLUG
Provides extra power for your portable radio / cassette player, simple to use, easy and convenient. Clips to your belt or pocket as a solar battery charger for rechargable batteries.
Z19015.......Only.$12.95

SOLAR BATTERY CHARGERS

SAVE $10

SOLAR CAR BATTERY CHARGER
Never worry about your car battery giong flat when left without being used over a prolong period of time. Simply place the solar power unit on your dash or near a window in your garage and plug it into your car cigarette lighter. The unit consists of solar cells in a housing with 1 metre of cable and cigarette plug.
Z19054 ..Was ~~$29.95~~
Now Just.............$19.95

SUPER SOLAR CAR BATTERY CHARGER
Z19052................$69.95

1/2 PRICE

SOLAR BATTERY CHARGER FOR "AA" SIZE BATTERIES
2 Cells & 2AAA cells
Z19050 Was ~~$18.95~~
Now Just $9.95

SAVE $10

"C" & "AA" SIZE SOLAR BATTERY CHARGER
One of the cleverest battery chargers ever made. This battery charger doesn't just charge "C" size batteries it also chargers "AA" batteries Never be without powe again. Great for camping, fishing, boating etc. So compact it can be taken anywhere.
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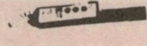
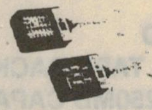
Now Just $9.95



KEYCHAIN BATTERY ANALYZER FOR TESTING ALL SIZES OF BATTERIES
Z19062.........Only $4.95

SOLAR LIGHTS

SOLAR CAR EMERGENCY LIGHT ANS CHARGER
Use this great device as an emergency light/blinker. or as a torch light for repairing your car etc. in the dark. The solar panel can be adjusted to different angles for better absorbsion of sunlight. Can also be used as a straight forward battery charger for for charging rechargable batteries Comes with 2 NC standard rechargable batteries.
Z19053 Was ~~$29.95~~
Now Just...........$27.95



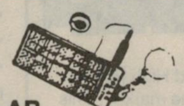
SOLAR MUSICAL KEYCHAIN WITH LIGHT
Never lose those keys again with this clever little device. The solar powered keychain with light will let you know where you left your keys just by listening for the music. The solar powered light will always let you find that illusive keyhole in the dark.
Z19060.................$4.95

SAVE $10

RECHARGEABLE SOLAR LIGHT
• Automatically turns on at night and turns off during the day.
• Detachable solar panel for indoor or outdoor use. • Unique protection for low voltage discharge ciruitry makes charging easy and quicker!
• Easy to install, equipped witha ccessories for easy asseembly beside the house number, pathway, side of the house, in the garden, sitting room study room etc.
• Speedy Charging - Only 6 hours of charging will give 12hours of use at night. (Depending on location and time of year)
Z19060 Was ~~$49.95~~
Now Just...........$39.95

SOLAR EMERGENCY LIGHT
Never worry about getting caught in the dark when your batteries go flat in your torch. This Solar Rechargeable emergency light stores energy from the sun during the day so that the light can be used during the night.. Great for reading so searching in the car. Ideal for camping, Barbecues etc.
Z19061.......Just $19.95

SOLAR RADIOS



SOLAR MINI FM RADIO
Take this solar FM radio anywhere. It's lightweight & con convenient Can be hooked onto a keychain or clip it onto your belt or clothing. It can be charged off the sun or incandescent light. • Unique feature: This radio is equipped with an external DC jack (3.5mm) for quick recharge and operation during or no light.
Z19069 Was ~~$29.95~~
Sale Price..$24.95

SAVE $20

DYNAMO & SOLAR AM/FM RADIO WITH 4 WAYS POWER BACKUP.
This is the radio that every traveller should have! You will never run out of energy sources for this little radio because it has four different power sources: Solar power, Manual dynamo winding, DC charging, "AA" batteries.
Z19064 was ~~$49.95~~
Sale Price $29.95

SAVE $10

SOLAR AM/FM RADIO KEYCHAIN
Pocket size AM/FM radio with keychain and clip for easy listening anywhere, anytime.Where ever your keys go so does your solar radio.
Z19068..Was ~~$29.95~~
SalePrice......$19.95

SOLAR EDUCATIONAL TOYS

SOLAR MOTOR KIT
This is a great starter kit consisting of a 0.9V 400mA solar cell and a small motor with a 48" wire. Great for beginners or just the curious.
Z19040... Was ~~$9.95~~
Sale Price $7.95

EDUCATIONAL SOLAR ENERGY KIT.
Learn what solar power is and how to build your own solar system. With this great kit you can make an electrical circuit. Learn how to increase voltage, current and how to make a solar panel and produce energy from the sun.
Z19042 Was ~~$22.95~~
Sale Price...$17.95

1/3 OFF

SOLAR WOODEN MODELS
Build great little solar powered wooden models with these kits! There are 3 different kinds of models to choose from. A helicopter with working motor, an aeroplane with working motor or a gramophone that plays music. Each kit contains a set of precut plywood, PVA cement, assembly instruction sheet, solar cell module, musical IC or small DC motor, wire and sandpaper.
Z19044 Aeroplane
Z19046 Gramophone
Z19048 Helicopter
Were $19.95 Each
Sale Price $13.95 each

SAVE $15

SOLAR VENTILATOR
Specially designed to circulate the air inside your house, apartment, home unit, kitchen, toilet, bedroom etc.
• Ventilate the hot air slowly & smoothly with soft air, not a violent breeze which can untidy & dusty. • Works directly from the sun. Does not need a battery.
Z19055...Was ~~$39.95~~
Sale Price.........$24.95

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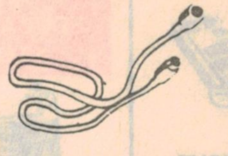


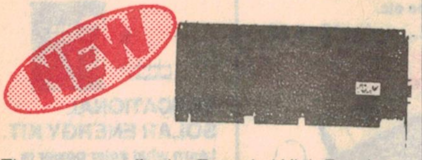
STRIAIGHT KEYBOARD EXTENSION LEAD

5 DIN Female - 5 DIN Male

1.8 metre lead (Straight)

P19043..........................$9.95

VESA 1M VGA CARD



The most cost effective Extended High Resolution VGA adaptor available on the market . This VGA card supports the past, the present and the future of colour graphics in PC computing.
It supports Standard IBM VGA resolution of 640 x 480, the new super standards of 800 x 600 and offers extended high resolution (1024 x 768 & 1280 x 1024) driver support for those needing extra special!

- Fast host access to video memory
- 256 Kbytes video memory configuration easily upgradeable to 512K bytes, 1M byte or 2M bytes of video memory
- Supports 132 column text mode on standard VGA (132 x 25, 132 x 43 and 132 x 60)
- Auto-switching (to match video modes)
- Analog (DB-15) connector integrated into backplane
- Fully compatible with IBM basic input/output system (BIOS)

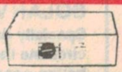
X18099......................................$129.00

SAVE ON POTS

POT PACKS
SPLINED SHAFTS
100 IN EACH PACK
JUST $9.99 A PACK!

These packs are very heavy. Please add an extra $3 .00 for postage and handling.

DATA TRANSFER SWITCHES



2 WAY DB25 PIN SWITCH BOX
X19120..............................$29.95
4 WAY DB25 PINSWITCH BOX
X19125..............................$39.95
2 WAY CENTRONICS
X19130..............................$34.95
4 WAY CENTRONICS
X19135..............................$49.95

250 MB TAPE BACKUP SYSTEM FOR IBM AND COMPATIBLE

Jumbo 250 Features:

- 250 MB Capacity using Data Compression
- Plugs into Floppy Disk Controller (500Kb/s amd 1Mb/s compatible)
- 40 MB Backup typically less than 7 minutes
- Novell, LAN tastic, IBM Token-Ring,and 3COM compatible
- Unattended Backup Scheduler Recording format
- Reads Jumbo 120 and QIC-40 tapes
- One year limited warranty
- Toll Free techical support
- Internal tape drive
- Backup software and manual
- Installation Manual - The Jumbo 250 is ready for internal installation in 286, 386, and 486 PCs. A picture guide steps you through the simple installation
- Compatability and accessory guide Made in the U.S.A.

X20242..$439.00

COLORADO PORTABLE TAPE BACKUP TRAKKER 250MB CAPACITY

Connects directly to the parallel port, Comes pre-assembled QIC-80

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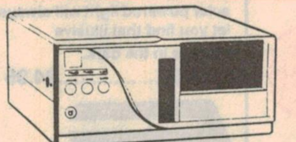

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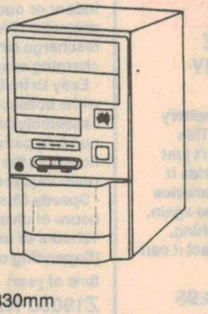

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Circuit & Design Ideas

Interesting circuit ideas from readers and technical literature. While this material has been checked as far as possible for feasibility, the circuits have not been built and tested by us. We therefore cannot accept responsibility, enter into correspondence or provide further information.

Mower battery voltage control

This on/off regulator was added to my 12hp B&S powered lawnmover, to prevent the battery overcharging. When the machine was used for long periods, I found that battery voltages in excess of 16V were common. The regulator could be added to any small engine with an electric start.

When the engine is started, relay RLB activates the unit automatically via contact RLB/1 to 'top up' the battery. If access to the alternator output is not available to switch this relay, then dispense with RLB and use a manual switch SW' instead.

The voltage control is based on an LF351 comparator (IC1), which uses a 78L08 (IC2) for a reference voltage, and compares this with the battery voltage via the potential divider composed of resistors R1, R2 and R3. Capacitor C1 smoothes the ripple appearing in the battery voltage. At start-up uncharged C1 holds pin 2 of IC1 low, so relay RLA is energised and connects the charger via contact RLA/1.

When the battery voltage rises to 13.8V, the comparator switches and de-energises RLA. Hysteresis provided by resistor R6 prevents the relay from re-operating until the battery voltage falls to 12.8V (or the engine is re-started).

The value of resistor R1 may be varied to change the 'fully charged' voltage. Do not measure this voltage while the battery is charging, as the ripple present will cause a false reading.

But when is a battery 'fully charged'? My answer to this question is when the terminal voltage settles to around 13.8V within a minute or so of ceasing charging. I didn't want my circuit to cut out charging, then switch back on again after a minute or so when the voltage had settled!

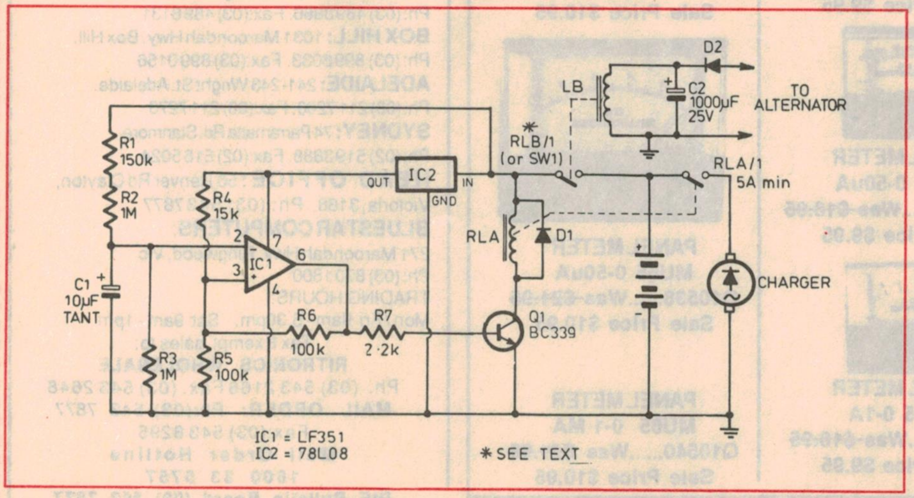
I found that a voltage of 14.2V, measured as soon as I ceased charging, settled to 13.8V a minute later. Because the comparator voltage needed for switching is measured while still charging, this setting must be made slightly higher than 14.2V, to allow for voltage drop caused by the battery's internal impedance. So my values for resistors $, R5 and R6 were chosen by trial and error to achieve this result.

These resistor valves gave me a turn-on voltage of 12.8V — which seems reasonable, as a fully charged battery would have a terminal voltage of around 12.5V after sitting for a day or so.

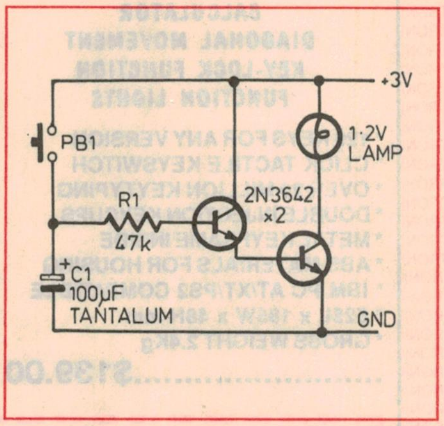
It is essential to connect the unit directly to the battery terminals, to avoid effects due to the charging current. Likewise, the negative lead from relay RLB and capacitor C2 should be taken separately to ground.

Remember that the unit will be subjected to considerable vibration, and must be constructed to withstand these conditions.

John Symons,
Woodend, Vic **$45**



Keyhole light



Have a problem finding your keyhold on a dark night? The solution is to build this circuit into a small box attached to the door jamb near the keyhole. Press pushbutton PB1, and you have for a couple of seconds or so — enough to enable easy insertion of your key.

The circuit is a simple timer. When pushbutton PB1 is pressed momentarily, capacitor C1 charges and turns on the two transistors, connected as a Darlington pair. This turns on the 1.2V lamp.

Then C1 discharges slowly through resistor R1 and the transistors, and the lamp turns off. The light duration can be increased by increasing the value of capacitor C1. Note that the value of resistor R1 is selected to give adequate light, not necessarily a full turn-on. To saturate the Darlington pair would require a lower value for R1, and hence give a shorter on-time.

My prototype was fitted in the smallest DSE zippy box, with the few components placed on veroboard. The lamp was attached with stiff wires and angled to shine througha slot cut in one end of the box.

I actually used the supplied metal plate as the pushbutton, mounting it just clear of the plastic lid. When the metal plate is tapped, it makes contact with a bolt attached to the plastic lid just beneath it and completes the turn-on circuit.

A.J. Lowe,
Bardon, Qld **$30**

Electrically-operated garage door

This circuit controls an electrically operated garage door. Its input is a positive pulse from a remote control receiver (radio, infra-red, etc.), and the relays at the output control a 12V motor. (I used a windscreen wiper motor from a car.) Upper and lower limit switches prevent the motor trying to drive the door too far. The circuit operates as follows:

Assume that in the quiescent state the two D-type flipflops in IC1 (4013) are reset — that is, the Q outputs are low. Transistors Q2 and Q3 are off, as are the two relays RLA and RLB. An input pulse from the receiver passes through switch S1 (a panel-mounted pushbutton) and IC2a (4093). This pulse can also be generated manually by pressing PB1. If the pulse is long enough to discharge capacitor C11 back through resistor R3 and IC2a (about 50ms), then IC2b goes high, sending a clock pulse to the two flipflops.

If the door is down, then the lower limit switch SW2 is closed, and the 'down' flipflop IC1b is held reset (active high), as the RST input (pin 10) has precedence over the clock. The clock pulse on the 'up' flipflop IC1a sets its Q output high, which turns on the up relay RLA. The motor then lifts the garage door. When the door reaches the top, it closes the upper limit switch SW1, which resets the flipflop and turns off the motor. IC1a is held 'reset' because SW1 remains closed until the door is driven down by the next input pulse setting the down flipflop.

If the door is stopped part way, neither limit switch is closed, so a clock pulse applied to the flipflops will set them both; but if this happens, the up one takes precedence, because IC2c and IC2d immediately reset the down flipflop.

Over-current sensing is provided by resistor R16 and the voltage comparator IC3 (LM311). A preset reference (adjustable via the 50k trimpot RV1) is applied to the positive input of the comparator and a portion of the voltage across R16 is applied to the negative input. About 100mV of hysteresis is produced in the comparator by the positive feedback resistor R9. If the voltage across R16 rises so as to cause the voltage on pin 3 to exceed that on pin 2, then the comparator output goes low, causing the output of IC2d to go high and transistor Q1 to turn on. This resets both the down and up flipflops.

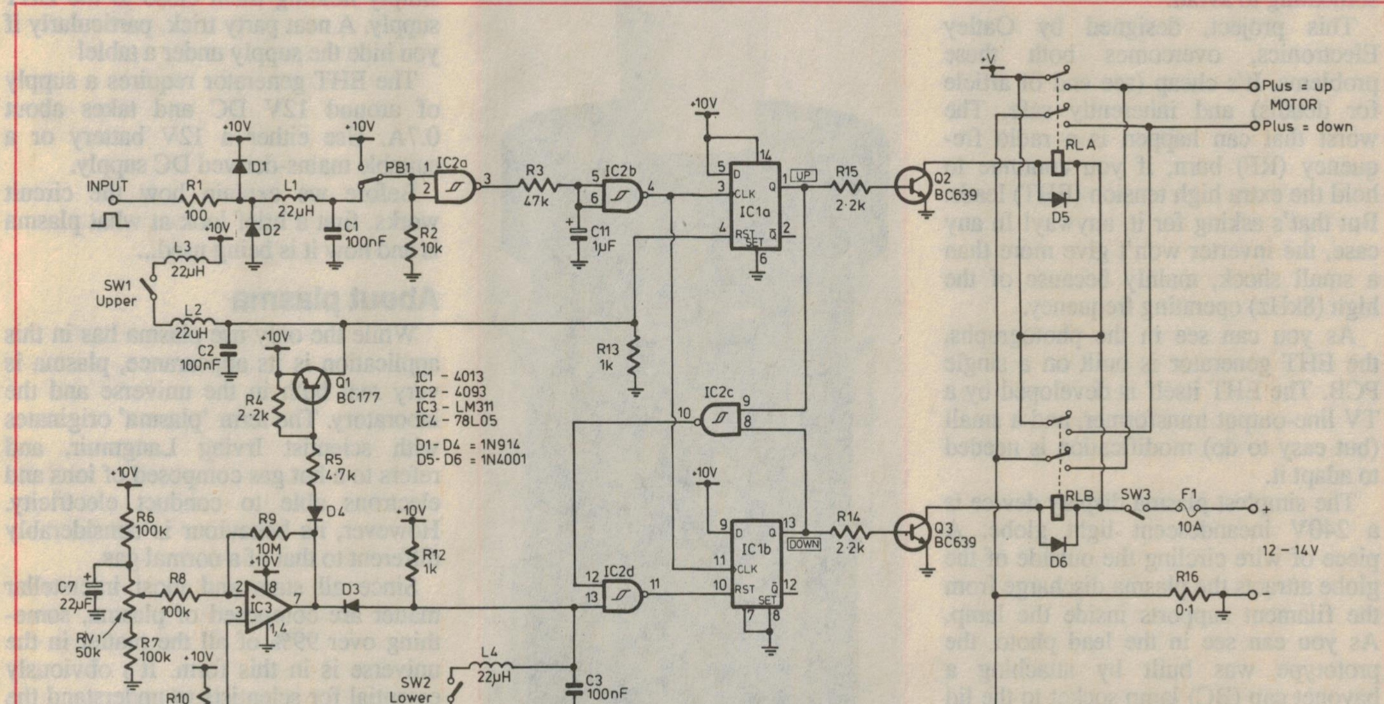
Capacitor C8 stops motor noise triggering the comparator, and the value of C7 was chosen to ensure that both flipflops are reset at power-on, since the voltage on pin 2 of IC3 rises more slowly than that on pin 3.

The voltage regulator IC4 is protected from motor spikes by zener diode ZD1; while five RF chokes are used in the lines connecting the unit to the outside world, to prevent the door being operated by RF interference from nearby transmitters.

The circuit's immunity to interference is enhanced by using standard low speed CMOS logic devices on a 10V supply rail. My unit has been in use for two years and has never malfunctioned due to interference.

I also found it useful to mount a lamp on the outside of the garage, connected in parallel with the motor, to indicate at night that the door was opening.

K.W. Gooley,
One Tree Hill, SA **$50**



Construction Project:

Low cost Plasma Display

If you thought a plasma ball was beyond your budget, try this one. The electronics is simple to build, the display is a conventional light globe and everything fits in a coffee jar! All you then need is a 12V DC supply. It will amaze (and amuse) everyone...

by PETER PHILLIPS

Things that glow in the dark are a source of great wonderment to children and hold fascination for most of us. Plasma discharge displays are particularly popular as the random patterns are great to watch, and the eerie glow is attractive and intriguing.

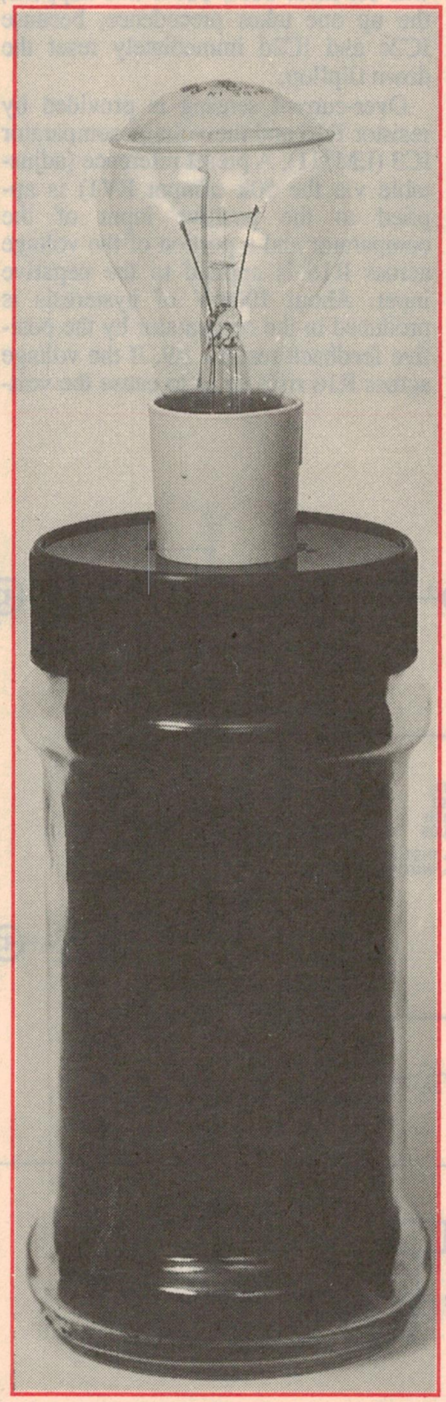
But many people are put off by the price of a plasma ball, as it's hard to justify the cost of something that does nothing except generate interesting displays. Also, the high voltage required to produce the display can be rather dangerous, and is therefore seen as something to avoid.

This project, designed by Oatley Electronics, overcomes both these problems. It's cheap (see end of article for details) and inherently safe. The worst that can happen is a radio frequency (RF) burn, if you continue to hold the extra high tension (EHT) leads. But that's asking for it, anyway! In any case, the inverter won't give more than a small shock, mainly because of the high (8kHz) operating frequency.

As you can see in the photographs, the EHT generator is built on a single PCB. The EHT itself is developed by a TV line-output transformer, and a small (but easy to do) modification is needed to adapt it.

The simplest plasma display device is a 240V incandescent light globe. A piece of wire circling the outside of the globe attracts the plasma discharge from the filament supports inside the lamp. As you can see in the lead photo, the prototype was built by attaching a bayonet cap (BC) lamp socket to the lid of a coffee jar. The electronics fits inside the jar with leads brought out for the 12V DC supply.

This type of display is the most popular, as you can change the pattern by touching the globe. Incidentally, you'll feel some heat at the point of contact and maybe a small tingling sensation. However, to make things more interesting, Oatley Electronics have available a limited number of low-pressure sodium discharge lamps, which will only be sold over the counter (due to mailing restrictions). When connected to the inverter, the lamp glows like a neon tube, but an attractive pink to mauve colour instead of the usual orange colour. Considering the discharge path is over 800mm long, you get quite a display! However you don't get the changing display as with a conventional lamp.



Another fascinating effect is lighting fluorescent tubes or neon lamps by simply holding them close to the EHT supply. A neat party trick, particularly if you hide the supply under a table!

The EHT generator requires a supply of around 12V DC and takes about 0.7A. Use either a 12V battery or a suitable mains-derived DC supply.

Before we explain how the circuit works, first a brief look at what plasma is and how it is being used...

About plasma

While the only use plasma has in this application is its appearance, plasma is very real both in the universe and the laboratory. The term 'plasma' originates with scientist Irving Langmuir, and refers to a hot gas composed of ions and electrons able to conduct electricity. However, its behaviour is considerably different to that of a normal gas.

Since all stars and most interstellar matter are composed of plasma, something over 99% of all the matter in the universe is in this form. It's obviously essential for scientists to understand the nature of plasma if an understanding of the universe is to be achieved.

The study of plasma has included the use in *magnetohydrodynamics* (MHD) which refers to the interaction of electrically conducting fluids and magnetic fields. Research using plasma rather than liquid was commenced in 1949, with an aim to develop a method of producing electricity.

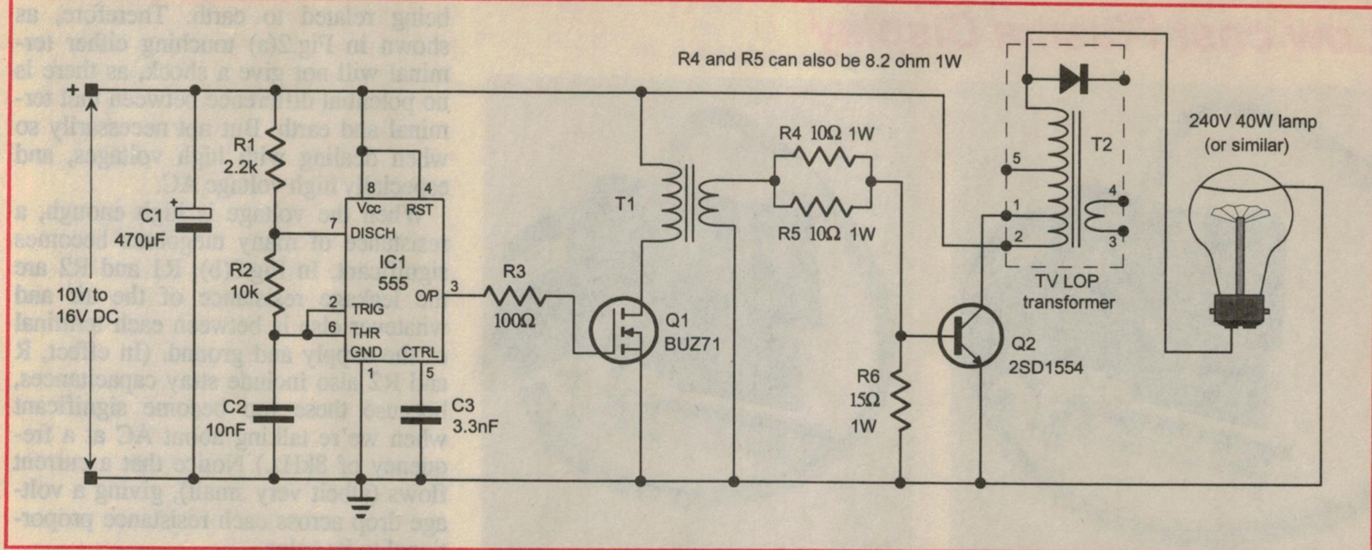


Fig.1: The 555 timer oscillates at around 8kHz, driving MOSFET Q1 via R3. The MOSFET supplies drive power to Q2, which switches power to the line output transformer T2. The internal diode in T2 is not used.

Hydromagnetic electric generators that project powerful jets of hot, partially ionised gas across a magnetic field are now capable of producing useful electric power from electrodes placed in these jets. Given suitable development, generators of this type are likely to be more efficient than existing steam-turbine generators.

An example involving plasma we are familiar with is the effect of hydromagnetic interaction between the sun's plasma and the earth's magnetic field. Here the relatively high-velocity plasma ejected from the sun by hydromagnetic activity encounters the earth's magnetic field, producing auroras and magnetic storms.

On a more esoteric note, various types of plasma motors have been developed that project plasma at high velocities with an efficiency greater than 50%. The plasma rocket is still to be realised, but the development of the so called *thermionic plasma diode* could provide the breakthrough.

A magnetohydrodynamic motor is an another example of using plasma for propulsion, where magnetic fields direct and accelerate a plasma jet. The advantage is there is no need for a nozzle, as in the plasma motor.

So, plasma is far from being simply something to look at and be amused by. In this project, plasma is produced in an incandescent light globe by the high voltage ionising the argon (an inert gas) inside the globe. The ionisation is confined to threadlike discharge paths, which move randomly from the filament support to the glass envelope.

Touching the glass attracts the plasma, as there is a lower resistance path to earth at the point of contact. The plasma will be attracted to this point and the heat of the gas will be felt through the glass. In fact, you won't be able to hang on for too long.

If you allow the discharge to remain at a single point on the globe, the glass will eventually puncture and the lamp will be destroyed. This can happen if you use a metallic object with a sharp point to attract the plasma.

So the essential components of a plasma display are a gaseous discharge path and a high voltage to cause ionisation of the gas. The electronics of this project produces the high voltage, as we'll now explain...

EHT generator

The circuit of the EHT generator is shown in Fig.1. It produces an output voltage of around 20kV AC from an input of 12V DC, and takes about 700mA from the supply. This is a high efficiency, as the input power is about 8W, while the output power is around 5W. Therefore there is only some 3W of heat dissipated in the circuit.

The 555 timer IC1 is connected as an

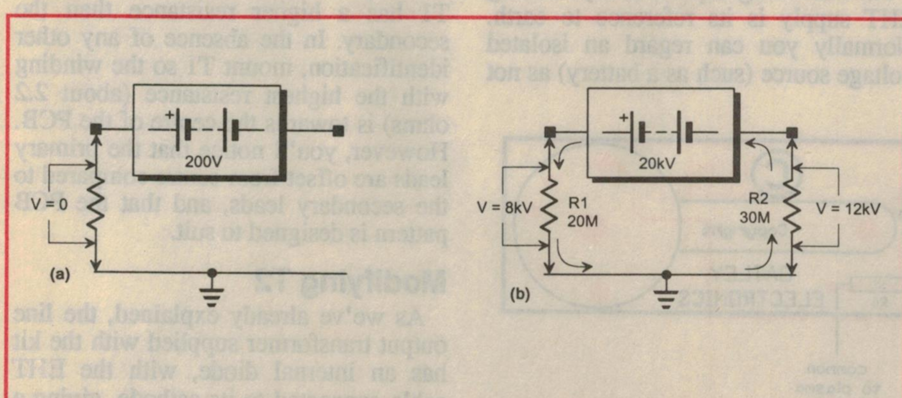


Fig.2(a): The leakage resistance from each terminal to earth of a 200V supply is too high to reference it to ground. Fig.2(b): Although the leakage resistance is many megohms, it's high enough to connect a 20kV supply to ground, making either terminal a potential shock hazard.

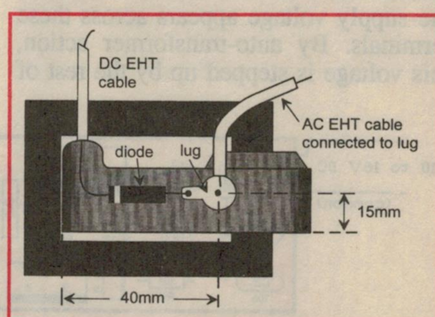


Fig.3: To contact the lug buried in the plastic case of T2, drill a 5mm hole to a depth of 3.7mm at the position shown. The position is not critical due to the size of the lug. Cut the existing EHT lead and solder it to the lug to get high voltage AC rather than DC.

Low cost Plasma Display

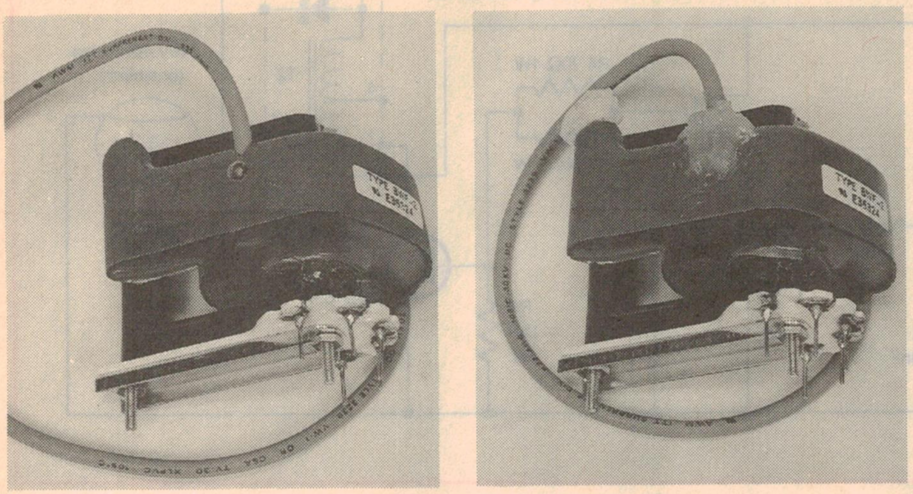


***Fig.4:** As these photos show, drill into the side of the transformer to contact the buried lug, then drill down from the top to insert the EHT lead. Seal the holes with silicone glue when you've finished.*

astable and produces a square wave at its output (pin 3) at a frequency of about 8kHz. This frequency is determined by the timing components R1, R2 and C2. Notice that R2 is larger than R1 to give almost equal high and low times of the output waveform. This is because the charge path of C2 is via R1 and R2 in series, while the discharge path is via R2 only. As R2 is five times larger than R1, the effect of R1 in the charge path is relatively small.

The output of the 555 connects through R3 to the gate of the N-channel MOSFET Q1. A positive voltage on the gate switches the MOSFET on, allowing current to flow in the primary of T1. The output waveform at the secondary of T1 is a square wave with sufficient power to drive Q2.

When Q2 is switched on, current flows in the winding of the output transformer between terminals 1 and 2 and the supply voltage appears across these terminals. By auto-transformer action, this voltage is stepped up by the rest of the winding for application to the plasma display device.

However, it's a little more complex than this, as the output waveform is a series of short duration positive pulses, rather than a square wave. There are all kinds of effects causing this, including the resonance of the transformer. The end result is a series of high-voltage short-duration pulses spaced about 125us apart.

Some readers will recognise this waveform as typical of that in a TV set, where the pulses are known as 'flyback' pulses. However, in a TV set the EHT to the picture tube is DC, while it's AC for this application. Therefore, as later explained, you have to connect to the AC voltage before it's rectified by a diode buried inside the transformer.

About EHT circuits

An interesting aspect of any floating EHT supply is its reference to earth. Normally you can regard an isolated voltage source (such as a battery) as not being related to earth. Therefore, as shown in Fig.2(a) touching either terminal will not give a shock, as there is no potential difference between that terminal and earth. But not necessarily so when dealing with high voltages, and especially high voltage AC.

When the voltage is high enough, a resistance of many megohms becomes significant. In Fig.2(b), R1 and R2 are the leakage resistance of the air and whatever else is between each terminal of the supply and ground. (In effect, R and R2 also include stray capacitances, because these too become significant when we're talking about AC at a frequency of 8kHz.) Notice that a current flows (albeit very small), giving a voltage drop across each resistance proportional to its value.

The important point is, that because of the high voltage, the supply is now referenced to earth by the leakage resistances. Whichever end you touch, there's a potential difference between that point and ground! To avoid this, it's better to earth one end and to regard the other end as dangerous. So if you're experimenting with this supply, or you want to ensure no one can get an RF burn, we suggest you earth the electrode that circles the light globe, on the outside.

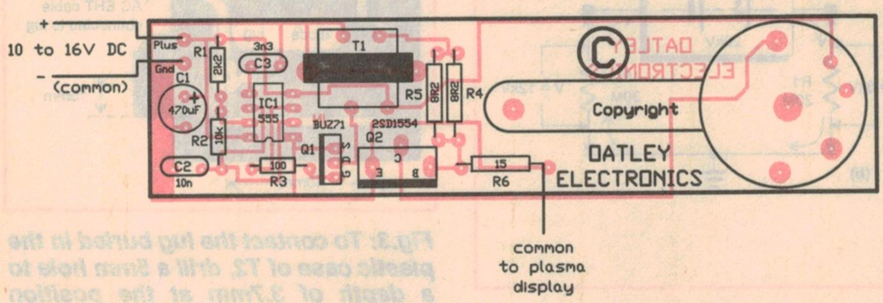
Construction

The EHT generator is built on a single PCB and construction is largely a matter of following the layout diagram. Transformer T2 needs modifying, so fit it last. Note that resistors R4, 5 and 6 are 1W rated and should be mounted above the PCB to allow air circulation around them. Mount transistor Q2 as high as its leads will allow and fit a heatsink to the tab. The MOSFET doesn't need a heatsink and should be mounted close to the PCB.

The primary winding of transformer T1 has a higher resistance than the secondary. In the absence of any other identification, mount T1 so the winding with the highest resistance (about 2.2 ohms) is towards the centre of the PCB. However, you'll notice that the primary leads are offset from centre compared to the secondary leads, and that the PCB pattern is designed to suit.

Modifying T2

As we've already explained, the line output transformer supplied with the kit has an internal diode, with the EHT cable connected to its cathode, giving a positive output voltage. You therefore need to drill into the plastic coating of the transformer and connect a lead to the anode to get an AC output voltage.



***The layout diagram.** Be careful to orient Q1 and Q2 as shown, with their back facing outwards. Also make sure you correctly identify the primary and secondary windings of T1 (see text).*

To do this, refer to Fig.3 which shows how to locate the place to drill. Refer also to the photos showing the process. Use a 5mm drill bit and carefully drill into the plastic until you hit a metal lug. You'll need to drill about 3.7mm into the plastic. If you strike black pitch, you've gone too far. (The windings are 2mm below the top layer of the pitch, so there's some leeway.)

Enlarge the hole sufficiently so you can solder to the lug. Cut the existing EHT lead flush at its entry into the plastic case, and reconnect it to the lug. Once done, seal all holes (including the point where the DC EHT cable was removed) with silicone glue. Once the glue has set, fit T2 to the PCB.

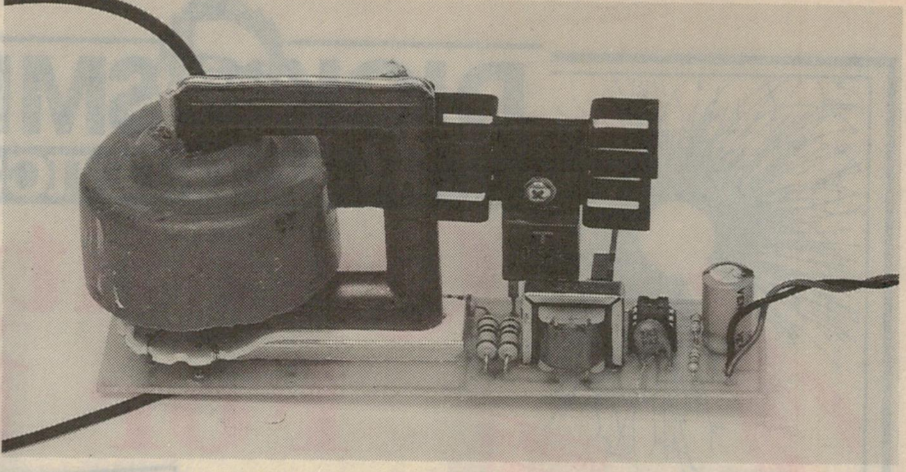


Fig.5: This photo shows a close up of the PCB assembly. Note the heatsink fitted to power transistor Q2. The driver FET doesn't need one.

Plasma ball

The plasma ball in the prototype is simply a 40W light globe fitted in a BC light socket, which is mounted on the lid of a suitable size jar. The jar and lid were spray-painted black. To provide a path for the plasma discharge, glue a loop of insulated wire around the top of the globe. This wire connects to the common line of the circuit, which is also the negative terminal of the DC supply.

As we've described, you might also want to earth the common line of the circuit. If the inverter is being powered from a mains derived supply, earth the negative supply terminal.

The inverter PCB fits inside the jar and the EHT lead from the transformer connects to one terminal of the lamp socket. Therefore, the only external wires are the loop around the lamp and the leads connecting the PCB to the 12V DC supply. If the loop is earthed, the EHT is completely contained in the jar.

Testing

Once you've built the PCB and fitted a loop around a light globe, you're ready to test. Lay everything on a cleared bench, connect the lamp and a 12V DC supply to the PCB. With power applied, the current consumption should be between 0.6A to 0.7A. This current will increase if you touch the surface of the globe, increasing the plasma discharge. Without touching the globe, you should see plasma discharge inside the lamp, indicating the EHT supply is functioning. You should also be able to hear the inverter working, as the operating frequency is around 8kHz.

The circuit is very easy to faultfind, and conventional test equipment can be used. However, stay clear of T2 and especially the EHT output, to avoid damage to the test equipment caused by the high voltage. Connect the earth of any test equipment to the negative terminal of the DC power supply.

Variations

When the unit is working properly, you should find that neon and fluorescent tubes will light up when placed near the EHT supply. This effect is enhanced if the EHT supply is loaded (with a plasma ball or similar), allowing current to flow.

If you have (or obtain) a sodium discharge lamp, fit it to a BC lamp socket and connect the EHT supply to both terminals of the socket. The lamp should glow for the full length of the inner tube (a total length of over 800mm).

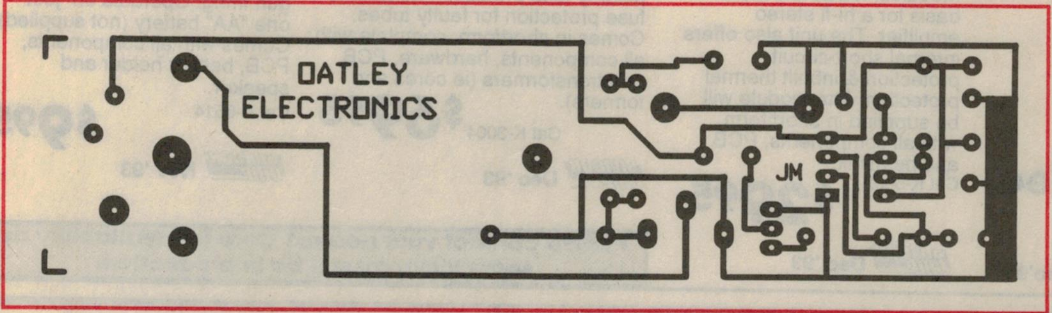
Remember that sodium lamps, while perfectly safe if handled correctly, contain a small amount of metallic sodium. If allowed to contact moisture, this substance can develop heat and possibly ignite. They therefore need to be disposed of properly. A warning notice with details of how to dispose of the lamp is usually supplied with these lamps.

The inverter can operate over a range of voltages, although the current consumption will increase, increasing the heat dissipation of the circuit. The minimum voltage is around 10V, and anything over 16V is not recommended.

You can use the inverter as a general purpose EHT supply. In this case you might want to leave the existing DC output lead (tucked away when not in use), and add another length of high tension cable to the lug, as already described, for the AC output.

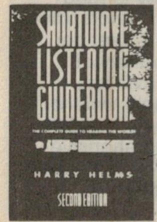
If you want to increase the frequency of the inverter so it's inaudible, lower the value of C1. Because the output voltage drops as the frequency increases, you'll need to compromise between performance and silence. The minimum value for C1 that worked satisfactorily in the prototype was 68nF. However, we recommend leaving the operating frequency at 8kHz, so you know when the inverter is switched on and if it's functioning properly.

You'll probably find many other ways to create inventive plasma displays with this unit, including using larger light globes or even a proper plasma ball. ❖



This is the artwork for the PCB, shown full size. The artwork is copyright to Oatley Electronics, and boards cannot be purchased from other suppliers. Private constructors can however, make their own boards.

Food For Thought!



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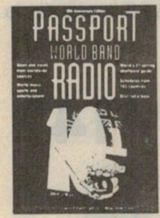

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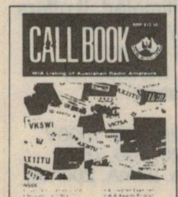

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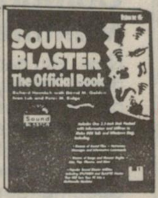

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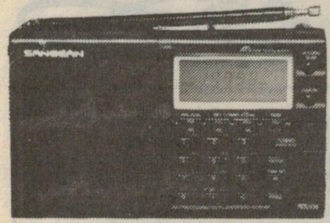

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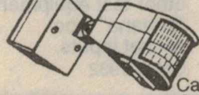

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Versatile 40V/3A lab power supply - 2

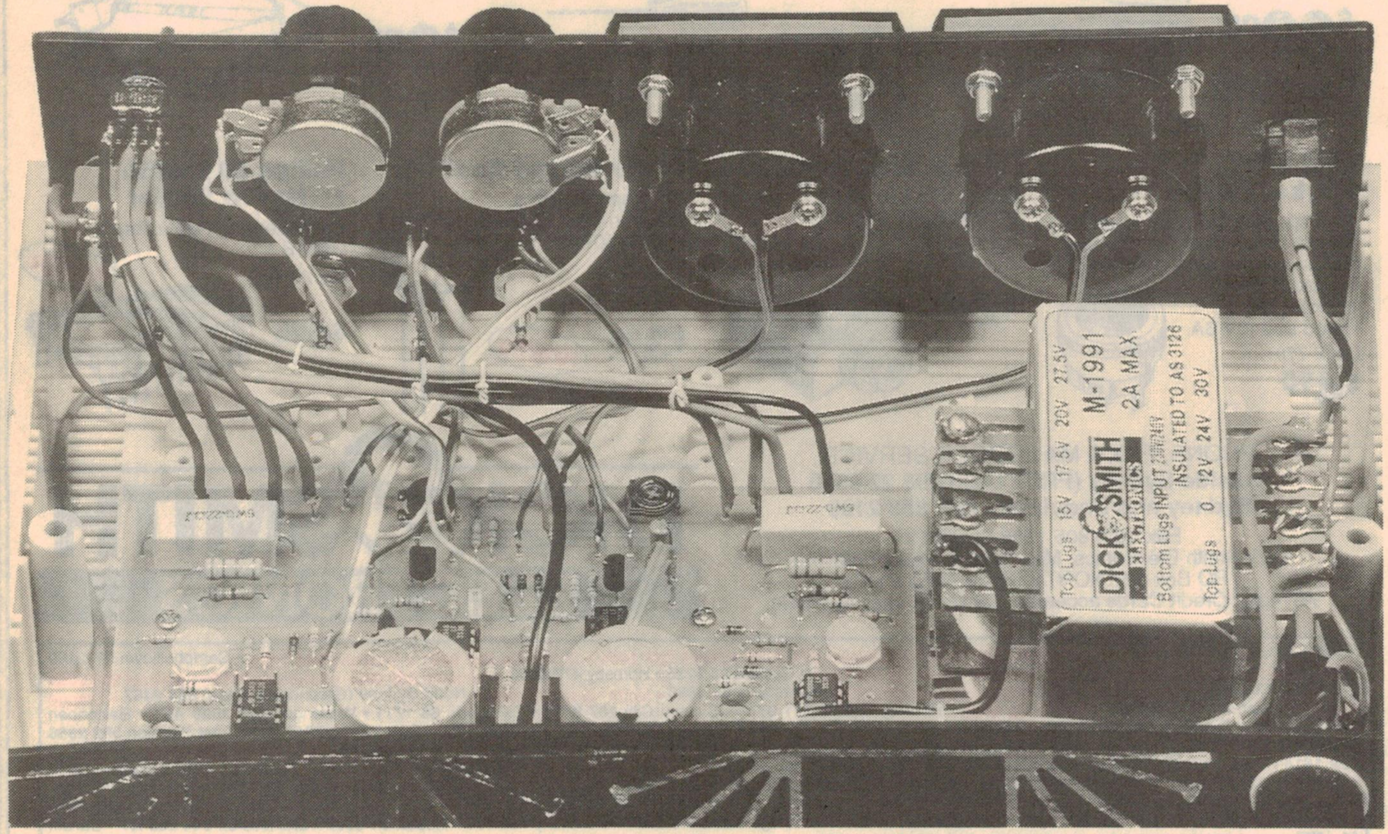
Following on from the first installment, here are the construction and setting up details for our new supply. When completed, you should find that it offers excellent performance, and is a very useful addition to your workbench.

by ROB EVANS

Most constructors will find putting the lab supply together to be quite a straightforward task, as there are few awkward or fiddly jobs involved. However, we recommend that you continually refer to the component overlay diagram as you install the parts, and cross check your work against both the schematic diagram and the associated shots of the prototype. The new lab power supply fits neatly into the largest in the range of standard plastic instrument cases, measuring 260 x 190 x 80mm, and most of the components are accommodated on a single PCB measuring 149 x 113mm (coded 93ps9). The remaining parts fit into the front and rear panels, while the transformer mounts onto a 120 x 68mm aluminium plate which is bolted into the bottom half of the case.

Commence construction by installing the smaller parts into the PCB as shown on the component overlay diagram, and work your way through to the larger items. Note that there are only two links on the board, but we've used PCB pins for all of the off-board connections — and there are quite a few of those...

If you don't feel like installing PCB pins at all of these points, you can connect appropriate lengths (and gauges) of wire directly to the pads, then terminate the remaining ends at a later stage. Bear in mind however, that if you need to remove the PCB *after* the supply has been completed, you'll have to unsolder (and later,



A view of the front panel wiring, showing the mounting position for C3 and the heavier wiring between the PCB and both SW1 and SW2. Guess where the transformer came from!

resolder) all of the connections at the front and rear panel components — not an easy job.

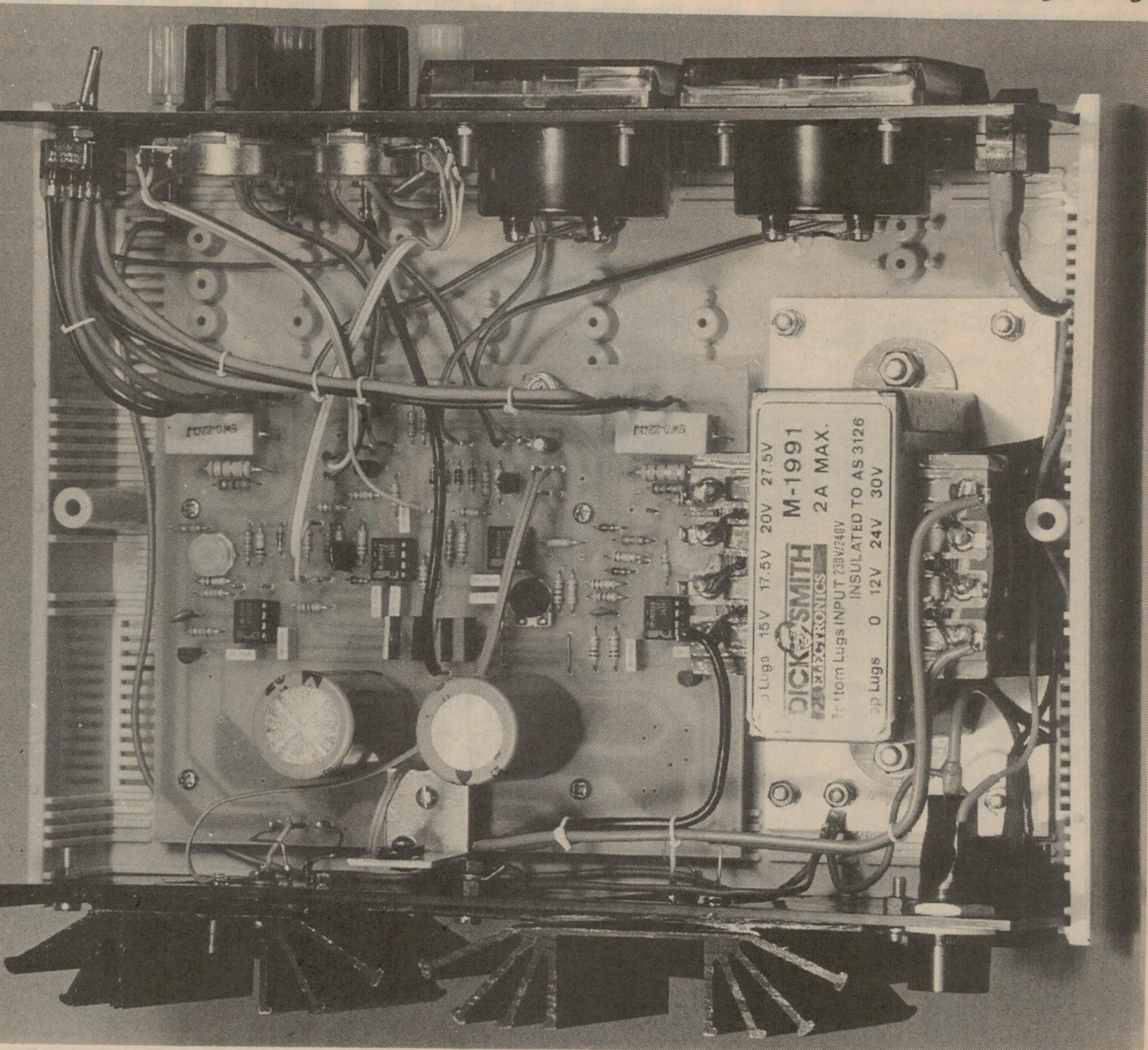
It's also worth noting that TP1, TP2 (and their associated grounding points, labeled 'GND'), plus R6 and R13 will all need PCB pins or short lengths of solid wire, for access during the setup procedure.

At this point, you might like to consider how accurate you wish the current readings to be between the 0.3A and 3A ranges. If you're happy to have a degree of error on the low range (at worst, around 10 or 15 percent), you can install *2.2 ohm* rather than 2.7 ohm resistors as R5 and R14 during the construction, and not bother with the trimming resistors (R6 and R13) which are fitted during the supply's calibration process.

Next fit all of the parts onto the PCB (except R6 and R13, if you've taken this path) while paying close attention to each component's position and orientation, as shown on the overlay diagram. Mount the 0.22 ohm 5W resistors (R4 and R15) slightly above the PCB to assist cooling, and fit the aluminium bracket/heatsink to the diode bridge (with a smear of thermal grease) before it's installed in the board. We simply fashioned the bracket from a scrap of aluminium plate, by the way.

The last, and largest components to install are the main reservoir capacitors, which are shown as C1 and C2 on the schematic and rated at 5600uF/40VW — the value used in our prototype. So that you're not locked into this specific type however, the PCB pattern has been arranged to accommodate a variety of other capacitor sizes and combinations, as shown in Fig.2.

This overlay diagram shows three possible arrangements of the rectifier and filtering section of the PCB, where axial-type capacitors are shown at the top, larger PCB-mounting units in the middle, and a combination of smaller PCB-mounting caps appear at the bottom. The only real requirement is that the total capacitance per side is more than about 4700uF, and has a voltage rating greater than say 30V — since the unloaded supply rail sits at around 22V, 25V capacitors won't quite have enough voltage headroom. Note that while the 5600uF/40V units used in our prototype match the size that's shown at the bottom of Fig.2 (but only two are needed), some capacitors with the same ratings have sig-



A plan view inside the completed unit, showing how the PCB and transformer are installed. The two driver transistors (Q2 and Q3) shown in this shot are smaller than those specified for the final unit, by the way.

nificantly larger dimensions, and can be fitted as shown in the middle diagram of Fig.2.

On the other hand, four PCB-mounting capacitors with a value of say 2500uF at 35V (or even larger) may prove to be more cost-effective or convenient, and can be fitted into the board as shown in the bottom arrangement of Fig.2 (C1A, C1B, C2A and C2B).

With the PCB assembly completed, you can begin to fit the remaining parts into the case, while using the photos of the prototype as a guide.

As mentioned above, the transformer is mounted on a section of aluminium plate, which in turn is bolted into the bottom half of the case — don't forget to fit a solder lug to the plate for the earth connections.

The heatsinks should be about 70mm in length, mounted with their fins vertically, and have a matching cutout in the case's rear panel for access. When prepared, the heatsinks can be bolted to the panel — we found just three bolts sufficient — and the series pass transistors Q1 and Q4 installed with insulating washers and thermal grease. We also installed plastic covers on both T03 transistors, to avoid the possibility of inadvertent shorts when the unit is on the bench.

Note that each thermal sensing transistor (Q5 and Q6) has its base and collector legs joined. Each should be installed with the metal face against the heatsink or bracket, and have a smear of thermal grease used at the mating surfaces. Also, the sensing transistor attached to Q1's heatsink (on the right) should be electrically isolated with a suitable mica washer.

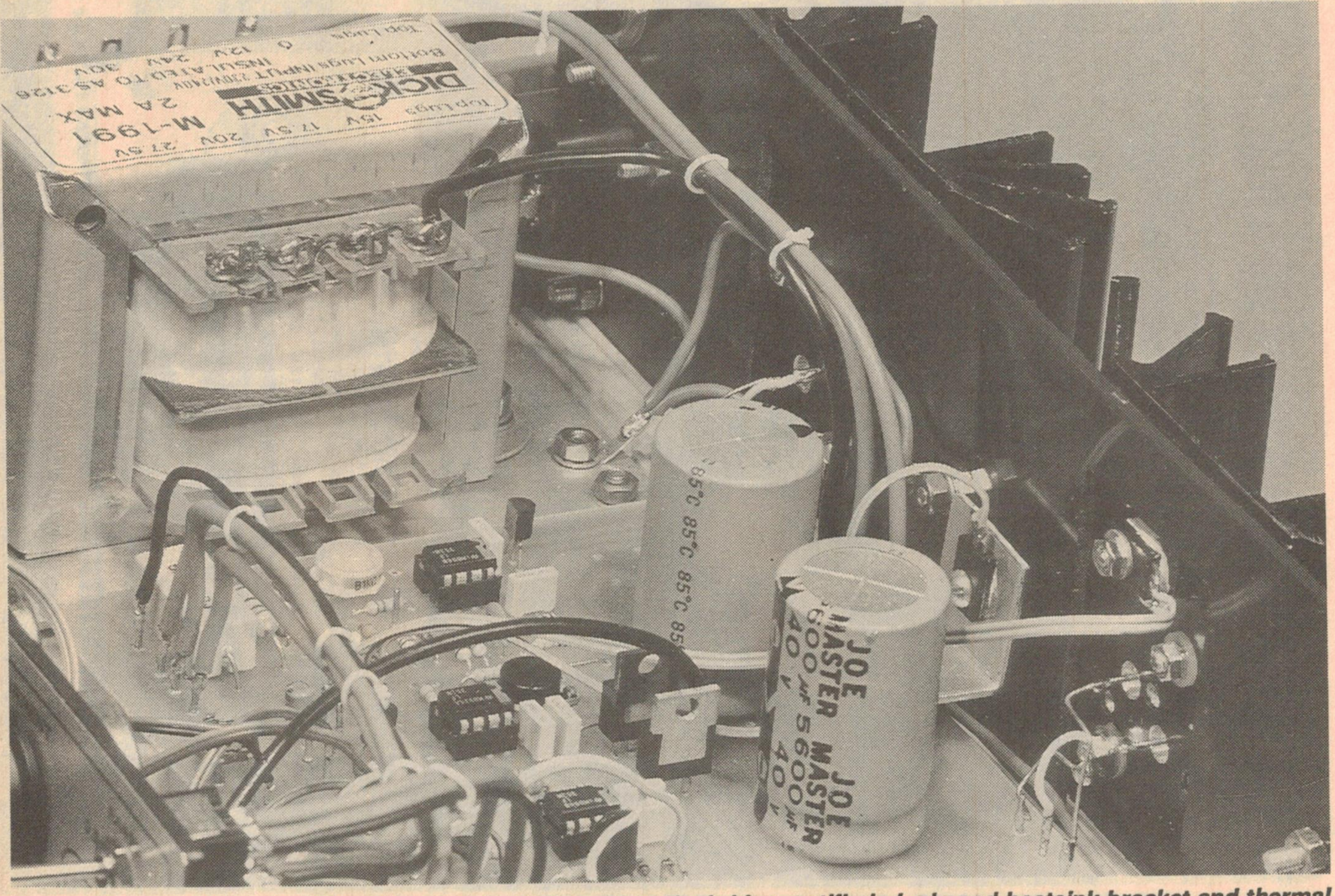
Once all of the remaining parts have been fitted to the case, the internal wiring can be completed. Use heavy-duty hookup wire for all of the high current paths (the transformer secondary connections, the wiring to SW1 and SW2, and the 0V output lead), and light-duty wire or sections of 'rainbow' cable for the remaining low voltage connections (pots, LEDs, meters, etc). Other than that, the emitters and collectors of Q1 and Q4 can be connected to the PCB using short lengths of tinned copper wire, and of course, all 240V AC connections made with mains-rated cable.

The voltage and current pots (RV1 and RV7, respectively) can be connected to the PCB via three-core lengths of rainbow cable, and terminated as shown in the overlay diagram.

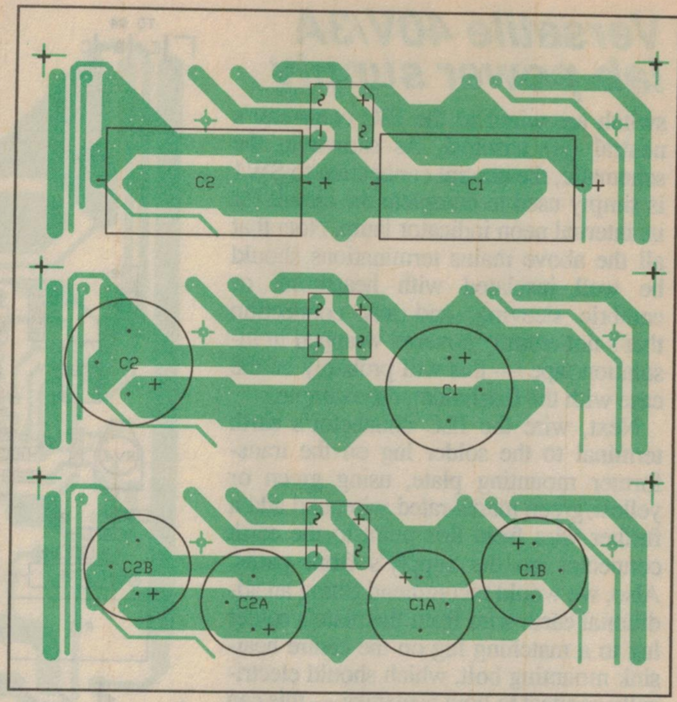
Here, 'CCW' corresponds to the pot's lug which is facing the moving arm (the wiper) when the shaft is turned fully counter-clockwise, and the 'CW' connection matches the lug facing the wiper in its clockwise position — and of course, the 'W' wire is for pot's centre wiper terminal. Also, note that the 'W' label for SW1 and SW2 refers to their moving arm connections (centre pin) in a similar fashion, and capacitor C3 is mounted between the CCW and W lugs on RV1.

Carefully follow the wiring order shown in the schematic, when it comes to completing the mains connections. The active (A) pin of the IEC connector should be wired directly to the fuse holder lug that's furthermost from the panel (at the end of the holder), and the remaining lug (close to the panel) wired to SW1 as shown. SW1's centre pin is then wired to one end of the transformer's primary winding.

Both the remaining primary winding lug and the remaining pin on the power

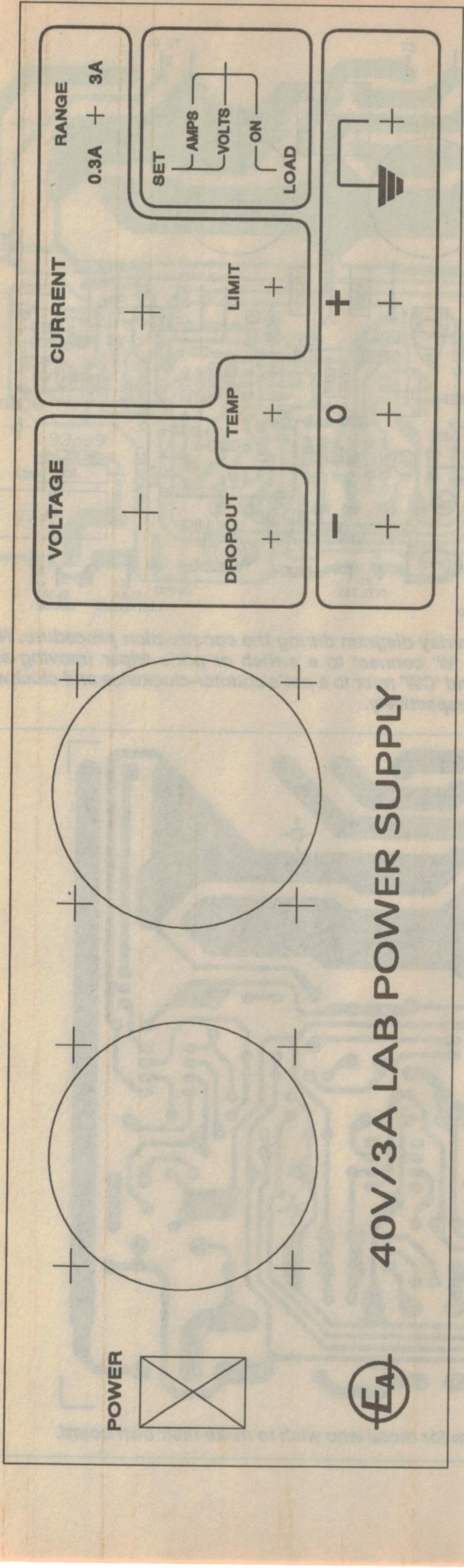


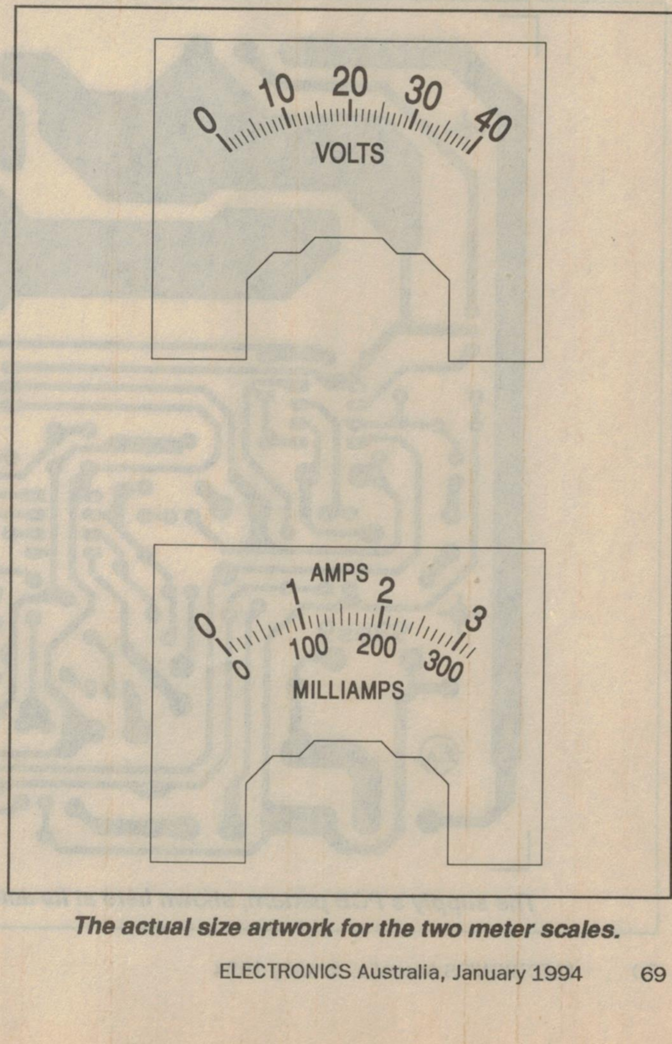
The supply's rear panel, looking from inside the box. Note the bridge rectifier's L-shaped heatsink bracket and thermal sensing transistor, which are just behind the nearest reservoir capacitor.



Above: Fig.2: Three alternative component overlays for the rectifier and filtering section of the circuit, to suit different styles of capacitors (see text).

Left: A full sized reproduction of the supply's front panel artwork.





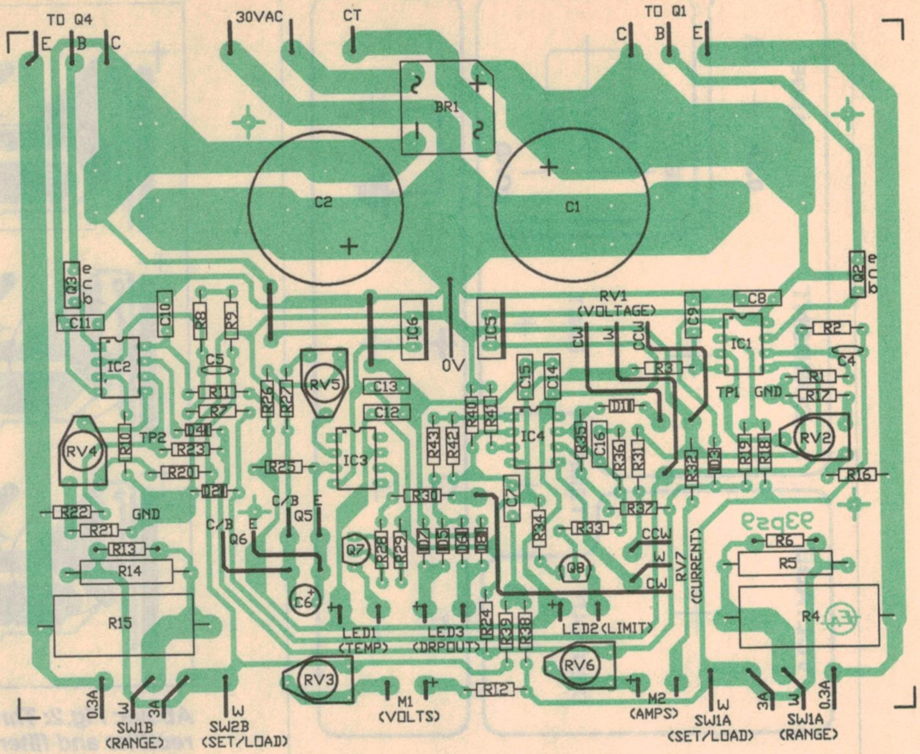
The actual size artwork for the two meter scales.

Versatile 40V/3A lab power supply

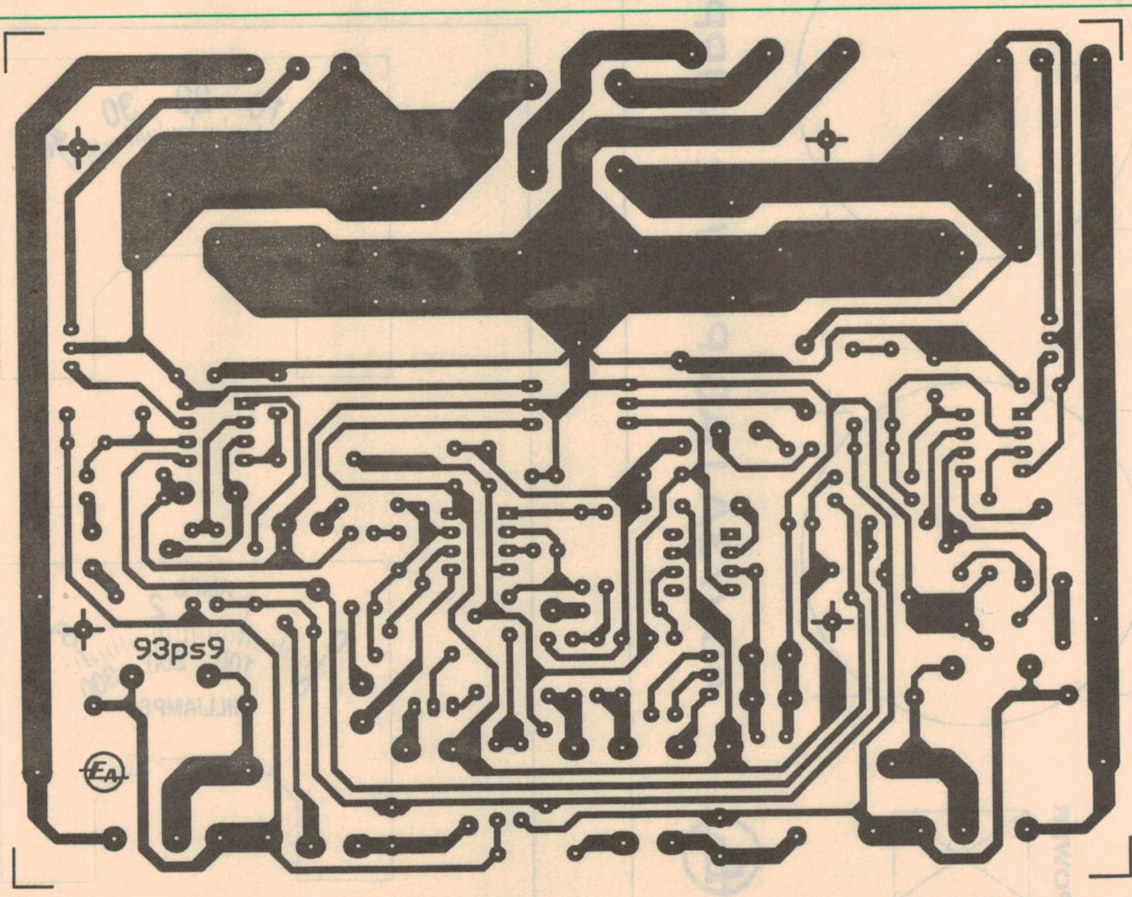
switch are wired to the IEC connector's neutral (N) terminal. As shown in the schematic, the neutral connection to SW1 is simply used to complete the circuit for its internal neon indicator lamp. Note that all the above mains terminations should be well insulated with heatshrink or cambric sleeving, and any connection that's not entirely covered wrapped in insulation tape — this will probably be the case with the fuseholder, for example.

Next, wire the IEC connector's earth terminal to the solder lug on the transformer mounting plate, using green or yellow/green mains-rated wire, and add a further wire from this point to the earth connector on the supply's front panel. Also, we would recommend fitting an additional earth wire from the plate's solder lug to a matching lug on the centre heatsink mounting bolt, which should electrically connect to both heatsinks — this can be checked for continuity with a multimeter.

Finally, double-check that all connections (particularly the 240V wiring) have been made as shown in the schematic and overlay diagrams — make sure that



Use this component overlay diagram during the construction procedure. Note that the leads marked 'W' connect to a switch or pot's wiper (moving arm) terminal, while 'CCW' and 'CW' refer to a pot's counter-clockwise and clockwise position connections, respectively.



The supply's PCB pattern, shown here at its actual size for those who wish to make their own board.

you've fitted C3, and *all* of the front panel wiring. There should be short lengths of heavy-duty hookup wire from the 'load on' terminals of SW2 to the appropriate output binding posts (+ and -), and a single connection from the 'current set' pin on SW2A (the positive side) to the 0V output terminal — this supplies a short circuit to the positive regulator while the current limit is being set by RV7.

Setting up, testing

Once you're confident that the supply's wiring is correct, mechanically zero the meter movements, select '0.3A' and 'set volts' on the range and load switches respectively, and apply power to the IEC connector. Immediately check that the reading on the Volts meter responds to adjustments of the Voltage control, and the 12V regulators (IC5 and IC6) are not running hot.

If all is well, make a few careful voltage checks around the PCB; the raw supply rails should be around 22V, and the low voltage rails should be close to +/-12V. You can also check that the supply's overall output voltage can be adjusted from 0V to about 40V with the Voltage control (RV1).

Next check the status of the LED indicators — with any luck, they will all be off. If the 'temp' LED is on, you should have noticed a problem by now, since its associated comparator (IC3) will have immediately shut down the supply's output voltage. Turning RV5 in a clockwise direction for a higher temperature setting should remedy this situation (more on its adjustment in a moment).

If the 'limit' or 'dropout' LED illuminates on the other hand, switch off the supply and re-check your wiring and the PCB. Since the load is not connected at this stage, there should be no current limiting action and the main regulators must have sufficient voltage headroom.

Once you are happy with the supply's basic operation, the PCB's various trimpots can be adjusted. Start with the current sensing amplifier balance presets, RV2 and RV4.

With the supply's output voltage adjusted close to its maximum level (say 40V), connect TP1 to its nearby ground pin (labeled GND in the overlay) with a shorting lead, and adjust RV4 for a zero reading on the current (Amps) meter. Then apply the shorting lead to TP2 and its ground connector, and adjust RV2 in the same manner.

When the lead is removed the meter should continue to read zero, since the two differential amps now have balanced input networks. The above procedure works by forcing the differential amp that's not being adjusted into its inactive state — that is, with its output at a low potential. So if we ground TP1 for example, the output of IC1B will fall, then the meter (M2) is driven by IC2B, and we can note the meter reading while adjusting RV4. Conversely, grounding TP2 will activate IC1B, allowing adjustment of RV2.

After that you can calibrate the voltage and current meters using a standard multimeter and a dummy load. Bear in mind however, that the common low-cost meter movements will have only a moderate accuracy through their range, and your best bet is to perform the adjustment with the pointer at around two-thirds of full scale deflection (FSD). Adjust the voltage meter with RV3, and the current meter with RV6 while SW1 is set to the *high* current range (3A) — this is necessary if you've fitted 2.7 ohm resistors for R5 and R14, since these are yet to be trimmed in value by R6 and R13, respectively.

Assuming that this is the case, connect a multimeter (configured to read current on its say, 2A range) across the supply's positive output terminals, select the 3A range on SW1, and adjust the current limit control for a reasonably high reading — say 1.9A. Then switch to the supply's 0.3A range and try a range of resistors (or a pot) in R6's position, until the multimeter reads 0.19A. Note that during this procedure the 'limit' LED should be on, and the supply's current meter (M2) should also be reading close to 1.9A when SW1 is in the 3A position.

Once you've found a suitable value for R6, this can be soldered in place, and a resistor of the same value installed as R13 — the equivalent component in the negative regulator's circuit. While you could take the trouble of repeating this setup process on the negative side, you would probably find that the final value for R13 is very close to that of R6, since most of the variables involved are the same.

The last adjustment involves the over-temperature setting adjustment, RV5. This can be adjusted on a trial-and-error basis, where the trimpot is set so that the temperature cut-out is triggered when either the diode bridge or Q1's heatsink becomes too hot to touch, or simply for a given voltage at the wiper of RV5 (pin 2 of IC3). In the latter case, we would suggest a setting of 0.48V — as shown in the schematic voltage readings — which appears to be quite close to the mark.

Mods & enhancements

While the lab supply in its published form uses standard parts and its design should suit most constructors needs, those who are building the unit up from scratch may wish to elaborate on the circuit, or use other components which may be at hand.

Since the 30V/2A transformer is one of the more expensive items involved, you may prefer to use a slightly different unit to run the supply. If this has a lower secondary voltage the supply will work quite happily, but with a reduced maximum output voltage as you would expect — you may be able to save a few dollars by using filter capacitors with a lower working voltage, as well.

If the transformer has a slightly *higher* secondary voltage on the other hand, you will need to ensure that the supply voltage to IC1 and IC2 doesn't exceed the op-amp's 36V rating.

This can be corrected by increasing the value of R3 and R11, so as to reduce the voltage between pins 8 and 4. Note that the theoretical maximum voltage for the raw supply rails is about +/-30V, since the 12V regulator ICs have a input voltage rating of around 32V, and the negative current sensing stage (IC2B) must have a positive supply rail (pin 8) of at least 5V to ensure an adequate output swing — if pin 8 is at 5V, then pin 4 must not exceed about -30V, as this would be a total supply rail of 35V for IC2.

You could also use a transformer with a higher output current capability, as this would help to maintain the supply's output voltage at high current levels. In this case however, you will need to consider the current rating (and cooling) of the bridge rectifier, and bear in mind that the dissipation in Q1 and Q4 will increase by a significantly level.

Other than that, some constructors may like to bolster the degree of thermal protection by adding further sensing transistors to the negative regulator's heatsink (for Q4), or even to the transformer itself. While the various sensors will operate in an OR fashion as described above, the shut-down threshold point (as set by RV5) will need to be adjusted on a trial-and-error basis.

And as a final point, a one ohm 5W resistor could be fitted between SW2A's 'set current' pin and the 0V terminal, in place of the length of wire used in the prototype. This would decrease the strain on the switch contacts to some degree, since when the supply's output has been set to high voltage, a large instantaneous current can flow through the contacts via the short.

With the resistor installed however, this momentary current is reduced by a substantial amount, which should extend SW2's working life. ❖

Project update:

New MOSFETs for audio power amps

If you have been planning to build the Playmaster Pro Series One power amp, but were put off by reports that Hitachi has discontinued the MOSFET devices used in its output stage, we're pleased to report that a new range of *direct* replacements are now available. In this short article we'll report on how these devices perform in the circuit, and also suggest a couple of simple ways in which the amplifier can be improved.

by ROB EVANS

Since the Pro Series One amplifier was presented in the December 1989, plus January and February 1990 issues of *Electronics Australia*, it has proved to be very popular with constructors seeking a high performance power amp which can be built for a fraction of the cost of a comparative 'high end' commercial unit.

It was hardly surprising, then, that we received a stream of correspondence from readers lamenting the fact that Hitachi had ceased production of the 2SK134 and 2SJ49 power MOSFET devices, and that as a result they were unable to build the amp — in fact, one correspondent even accused us of being downright irresponsible for designing a desirable, but 'obsolescent' project...

In this respect, we'd have to point out that the design has now been around for nearly four years and the MOSFETS themselves have been available since the early 1980's, which is a pretty good run by all accounts. And as it turns out the run is definitely *not* over, since Altronics has managed to find a secure supply of direct replacement MOSFETS for the amp. We should also mention that Jaycar Electronics has tracked down a sizable quantity of the *original* Hitachi devices.

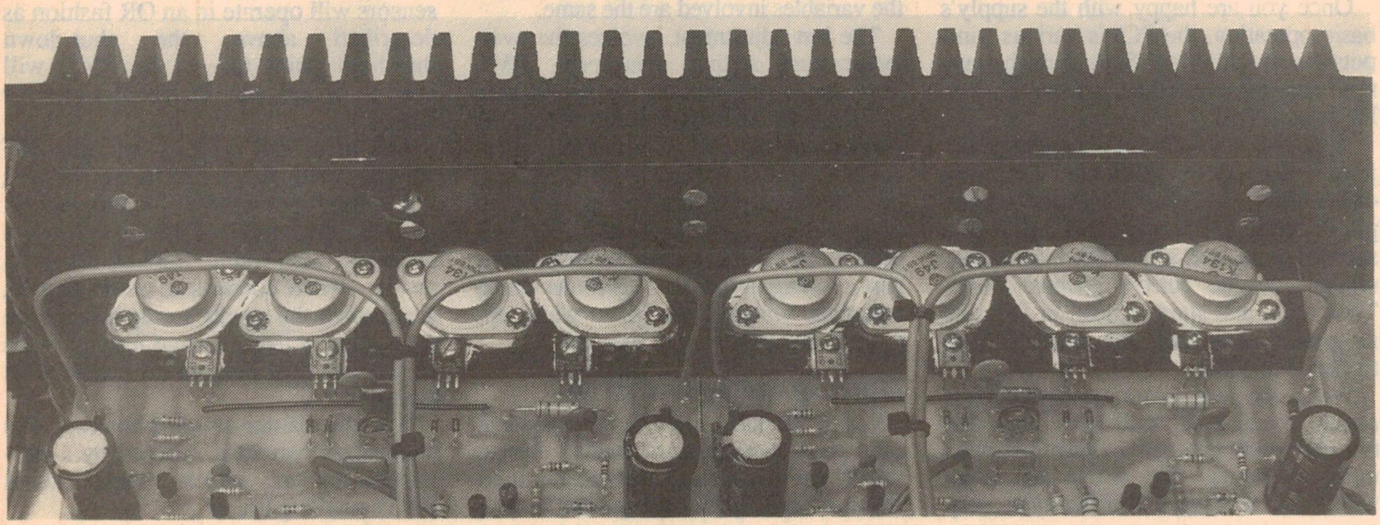
While there has been a price increase in both of the above cases, chances are that this will end up being a one-off purchase for constructors. This is thanks to the very rugged nature of the power MOSFETs, which allow the amp's output stage to withstand an extraordinary degree of overload without damage. In short, it's unlikely that you will ever need to buy a replacement set of MOSFETS.

The new MOSFETs

The MOSFETs to suit the Pro Series One on offer from Altronics are designated ECF10N16 (N-channel) and ECF10PN16 (P-channel), and are intended as a direct substitute for the original Hitachi 2SK134 and 2SJ49 devices, respectively. As it happens however, the Altronics MOSFETs have a maximum Drain-to-Source (Vds) rating of 160V, a maximum Drain current rating (Id) of 8A, and a power dissipation (Pd) figure of 125W, which are all significantly better ratings than those for the 'equivalent' Hitachi devices — whose Vds/Id/Pd figures are listed as 140V/7A/100W.

In fact the ECF10N16 and ECF10P16 MOSFETs are those with the *lowest* ratings in the new Altronic range, which offers three other sets of complementary pairs (matched N-channel and P-channel devices), all with higher ratings. These are the ECF10N20/ECF10P20 rated at 200V/8A/125W, the ECF20N16/ECF20P16 at 160V/16A/250W, and the ECF20N20/ECF20P20 rated at 200V/16A/250W.

As you can see, the latter two pairs in the range have pretty impressive specifications, and are the highest power MOSFETs of this type that



we've seen. So while the devices in this new range are mainly intended to replace the now defunct Hitachi TO-3 series, their capabilities are somewhat greater. For reference, the highest rated Hitachi MOSFET pair was the 2SK176 and 2SJ56 at 200V/8A/125W, which is equivalent to just the second level in the new series, the ECF10N20 and ECF10P20.

In the Pro Series One amp

According to both Altronics and the data sheets provided with our samples, the new MOSFETs offer very similar characteristics to the earlier Hitachi devices, and therefore should drop straight into existing designs. Since our main interest was with the Pro Series One amp at this stage, we duly removed the four Hitachi MOSFETs from one of its channels and fitted sets of the new ECF10N16/ECF10P16 devices in their place. With this arrangement, we then had the opportunity to directly compare the modified channel with that of the original (Hitachi) arrangement.

This was all somewhat of an anticlimax is it turned out, since from what we could tell from our lab instruments and listening tests, the modified channel performed just as it had with the Hitachi devices.

So happily, we can safely say that with the new MOSFETs the amp should still exhibit the same extremely low levels of total harmonic distortion (THD) and intermodulation distortion (IM) that are characteristic of the design. Both its continuous and IHF (pulse) power output capabilities are also retained, by the way.

Other changes

During the process of checking out how the new MOSFETs performed in the Pro Series One amp, we decided that this might be a convenient time to try out a couple of improvements that we've developed since the project was first presented. These are relatively minor changes, and existing owners of the amplifier may wish to make the modifications, as well as those about to build a new unit.

The first involves capacitors C9, C10 and C11, which are used to equalise the N-channel MOSFET's input capacitance to that of the P-channel devices, and to help stabilise the output stage. In practice the main benefit of these components is as an aid to stability, since while the MOSFETs have an input capacitance (Cgs) in the hundreds of picofarads, as source followers they only present a fraction of this to the preceding driver stage. Therefore the *practical* difference between the input capacitance the N-channel and P-channel devices is negligible — just a few picofarads, in fact.

In the light of this, we have determined a much simpler scheme to stabilise the output stage, which makes no attempt to compensate for differences in input capacitance. This involves removing C9, C10 and C11, and adding a 47pF ceramic capacitor between the gate and drain connections of each of the N-channel MOSFETs (Q9 and Q10) — which turns out to be a very effective stabilising technique for this circuit.

Note that the capacitors should be fitted to the underside of the circuit board and soldered directly to each MOSFET's PCB pads. The MOSFET's drain pins are those connected to the positive supply rail, and you will need two 47pF capacitors in all. Also, take care not to overheat these relatively fragile parts as they are being soldered in place.

The other modification involves lowering the value of Q5's load resistor (R11) from 12k to 8.2k, so as to raise the voltage at its collector to greater than 0V. This was found to cure the tendency of some amplifiers to deliver a series of quiet 'pops' to the speaker, some time after the unit has been turned off.

While the reasoning behind this minor problem and its solution is somewhat convoluted, it's suffice to say that with Q5's collector at around -18V (or thereabouts), the Q5/Q6 differential pair may 'shut down' in an uneven manner as the supply rails fall.

After several seconds the collector voltage at Q6 will eventually bias Q9 and Q10 on, which allows the positive supply to discharge through the speaker until the level at Q6's collector falls (in sympathy with the falling supply rail). This in turn shuts off Q9 and Q10, and so on. This continues through a number of cycles (a second or so apart) until the supply rails are fully discharged.

On the other hand, when R11 is lowered to around 8.2k the collector of Q5 will be at about +10V, and the differential pair will shut down in a more balanced manner — that is, the voltage at the collector of Q6 will remain close to 0V as the supply rails fall.

If you don't wish to actually remove R11 in an existing amp, by the way, you can simply install a 27k 0.25W resistor in parallel with the existing 12k resistor, producing a value of around 8.3k. Also note that changing the value of R11 to shift the voltage at the collector of Q5 will not affect the amp's sonic performance.

So that's about it. As you would expect, we're more than pleased that the Pro Series One power amp will be a viable construction project for some time to come, and we're sure that many readers will share our feelings about this popular project. ❖

STOP PRESS
New MOSFET amp on the way

Jaycar Electronics has sourced a supply of Hitachi's official replacement MOSFETs for their TO-3 style devices, which are now housed in a large plastic flatpack-type package designated TO-3P ('P' for plastic, presumably). These offer the same ratings as the original TO-3 devices, and will soon be available from Jaycar stores.

A new high-performance amplifier using these devices is under development in our lab, and at the time of writing is looking very impressive indeed. Without giving too much away, the new amp has been christened the 'Pro Series Three', and offers the same high performance as the Pro Series One but with a significant hike in power at very little (if any) increase in cost.

Stay tuned...

JAYCAR JANUARY MADNESS SALE

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If you purchase a VIFA SA70,100 or 130 speaker kit in January we will give you the cabinets free. There has never been a better time to upgrade your speakers. It is well known that VIFA speakers generally perform as well as built equivalents that cost twice as much. We are overstocked with VIFA cabinets, and need the warehouse space. See catalogue for full details.

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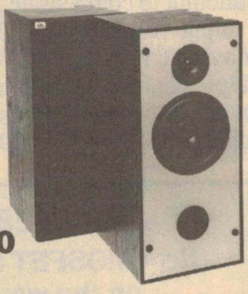
- 8" woofer
- Dome tweeter

$349 Pair
Cabinets worth $120 FREE

Vifa SA100
2 way kit
- Power 100 watts
- 8"woofer
- Dome tweeter

$549 Pair
Cabinets worth $170 FREE



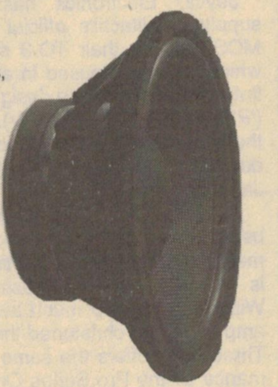
Vifa SA130
3 way kit
- Power 130 watts
- 10" woofer
- Dome tweeter

$779 Pair
Cabinets worth $250 FREE

QUALITY WOOFERS SLASHED

These three speakers are top quality with excellent specifications. Use them as a subwoofer or just a woofer. They have large magnets, pressed polypropylene cones, high power handling and excellent frequency responses. See our catalogue for full specificationss page 36.

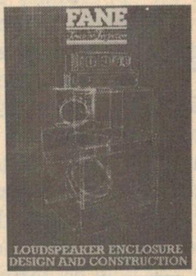
	Size: 6"	Size: 10"	Size: 12"
Power handling - RMS	60w	120w	150w
Frequency response	50-3khz	31-2khz	28-2khz
Magnet Weight	20oz(587g)	34oz(988g)	34oz(988g)
Free Air Resonance	50.3hz	31.1hz	28.1hz
Cabinet Size	10 litre	45 litre	48 litre
Cat No	CW-2162	CW-2166	CW-2168
Cat. Price	**$89.50**	**$129.00**	**$159.00**
Sale Price	**$59.50**	**$89.00**	**$119.00**
Save	**$30.00**	**$40.00**	**$40.00**



LOUDSPEAKER PUBLIC ADDRESS BIN ENCLOSURE DESIGNS BOOK

Fane acoustics have produced this excellent book on PA speakers. Learn how to seal, brace, line, wire cabinets. Includes 22 detailed designs for reflex, horns, w bins, wedge, folded, cabinets etc
Cat. BF-4150

was $19.95
now $14.95
save $5.00



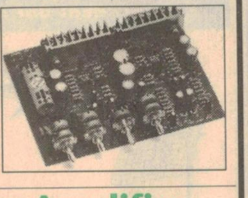
PREBUILT MODULE SPECIALS

See our 1993 Catalogue for full details and specifications.

30 + 30 Watt Stereo Amp

Inputs for MIC, phono + line. Has volume, bass, treble and balance controls. Connect a x'former speakers and a signal
Cat: AA-0300

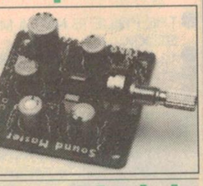
was $76.95
now $59.95
save $17.00



6 Watt Mono Amplifier

with volume control
Cat: AA-0340

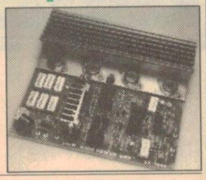
was $19.95
now $16.95
save $3.00



300W Power Amp Module

300 watts into 8Ω, 500 into 4Ω
Distortion less than 0.05%
Cat: AA-0330

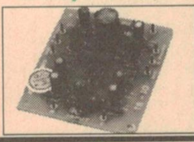
was $189.50
now $159.50
save $30.00



Stereo Preamp - Mic/Phono

Will bring up a phono input to line level. Cat: AA-0324

was $24.95
now $21.95
save $3.00

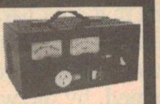


SAVE UP TO $50 ON INVERTERS

If you have been considering the purchase of an inverter lately, make it this month and save money. All units have inputs of 12VDC (except MI-5060) and outputs of 240VAC. For full specs and details see our 1993 catalogue.

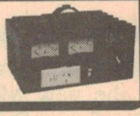
12V / 100 watt
Cat: MI-5035 **Was $134.95**
Jan $114.95, Save $20

12V / 500 watt
Cat: MI-5050 **Was $419.00**
Jan $379.00, Save $40

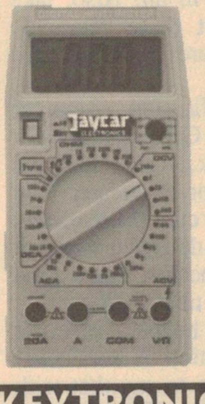


12V / 300 watt
Cat: MI-5040 **Was $259.00**
Jan $229.00, Save $30

24V / 1000 watt
Cat: MI-5060 **Was $649.00**
Jan $599.00, Save $50



DIGITAL MULTIMETER BREAKTHROUGH!!!



Jaycar Electronics are proud to announce a brand new range of digital multimeters that offer features per dollar that until now was unheard of. Jaycar are sole representatives of this new range, which at the moment has three models, with more due in 1994.

QM-1300
- 30 range
- Large 21mm display
- Transistor test
- Audible continuity test
- 20 amp

Cat: QM-1300
only $49.95

QM-1310
- Frequency
- Capacitance
- Transistor
- 21mm display
- Audible continuity test
- Auto power off
- 20 amp

Cat: QM-1310
only $79.95

KEYTRONIC KEYBOARD

Keytronic keyboards are known throughout the computer industry as top quality! We don't know what this keyboard is compatible with! It has 98 keys and is ideal for the experimenter/computer hobbyist. It is not supplied with a lead.
Size 510(W) x 220(D)mm. Cat. XC-5092

only $10

INSTALL THAT BURGLAR ALARM OVER THE HOLIDAY BREAK

BELLMATE

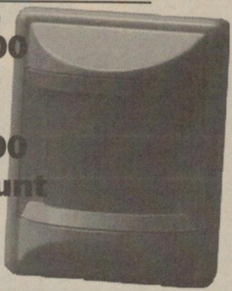
8 Sector panel
Normally $229
Now $199
Save $30
Cat: LA-5324

4 Sector Panel
Only $149
Cat: LA-5320

BELLMATE PIRS

THOUSANDS SOLD
Model 200
$34.95
Cat: LA-5017

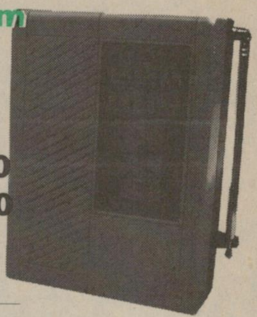
Model 100
Pulse Count
$49.95
Cat: LA-5016



102A Guardall Wireless Alarm System

Consists of
1-3 sector panel
1-PIR
1-Remote
1-240V Plug pack

Was $289.50
now $259.50
Save $30
Cat. LA-5221



SAVE ON CAR ALARMS

Take this opportunity to save money on a car alarm, and install it yourself during the holidays

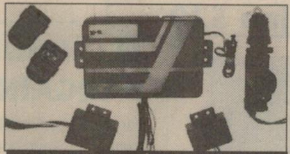
Remote Control Car Alarm

Cat. LA-8900
was $139.50
now $119.50
Save $20

Catalogue #: LA-8900

Alarm With Drivers Door Central Locking

Cat: LA-8902
was 199.50
now $174.50
save $25



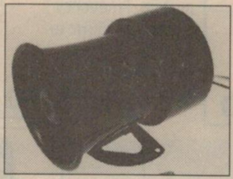
Catalogue #: LA-8902

Alarm With 4 Door Central Locking

Cat. LA-8905
was $279.50 now $249.50 save $30

SIRENS TO SUIT

Normal Siren Cat. LA-8908
was $24.95
now $21.95 Save $3



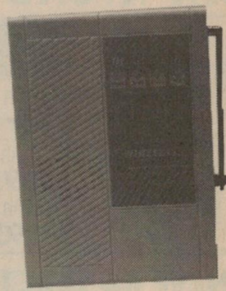
Backup Battery Siren

Cat. LA-8910
was $62.95
now $57.95
save $5

Model 105 Wireless Alarm System

Consists of
1-4 sector panel
1-PIR
1-Reed Switch
1-Remote
1-240V Plug pack

Was $399.50
Now $359.50
Save $40
Cat: LA-5220



10% Off Guardall Extras

Remote control was $44.95 Now $40.45	Cat: LA-5222
Pulse Count PIR was $99.50 Now $89.55	Cat: LA-5224
Reed Switch was $54.95 now $49.45	Cat: LA-5226

SEE OUR 1993 CATALOGUE FOR FURTHER DETAILS ON THESE ALARM PRODUCTS

WHAT A FLOP!!! FIRE BLANKET

There has always been a lack of interest by the public for safety problems. It started years ago when we purchased a large quantity of smoke detectors that no one else wanted to buy. This is another product that will save somebodys house or life, if there is one available when needed. Eveready thought they were a great idea and had them made to Australian Standard AS3504. The fire blanket measures 1.0m x 0.9m and is made from a special fibreglass cloth. It can be used to suffocate a kitchen fire, car fire, clothing fire etc. They used to sell for just under $50.00. Nobody bought them. We have bought a quantity of them and can sell them for $9.95. At that price you owe it to yourself and your family to have one handy.

Cat: LA-5092 **$9.95**

EVEREADY ANYWHERE LIGHT

Another surplus stock purchase. The anywhere light runs on two "D" size batteries and is ideal for use in closets, stairwells, attics, basements, camping, cars - anywhere where you need some light. It incorporates an on/off switch, and the light is from a torch globe. Size: 159(dia) x 50(deep)mm. These used to sell for around $25.00. We have a limited quantity available for only $9.95.

Cat: ST-3035 **$9.95**

ALARM INSTALLERS Contact us for wholesale prices on Burglar Alarm Gear & Accessories

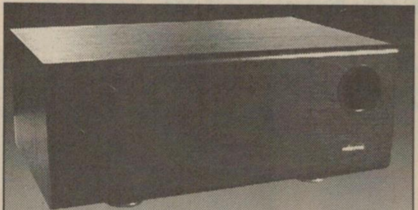
Sydney: 743-5222
Brisbane: 393-0777
Melbourne: 384-1811
Adelaide: 231-7355

SCRAMBLER PHONE SELLOUT

Jaycar has made a scoop purchase of telephones that scramble your message so that it can be deciphered only on a similar unit. You use by simply connecting in parallel to another phone. (The party on the other line must have a scrambler phone as well.) These units once sold for $299. You can own a scrambler phone for the ridiculously low price of $39.95 each! Remember, you will need at least two though. The stock is brand new, in cartons and has a three month warranty. Unit requires 9V DC to operate. (Cat. MP-3007 $15.95).
Cat. YT-7000

Was $39.95 Now Only $25 EACH

SAVE $20 ON RE/SPONSE STEREO MINI SUBWOOFER SYSTEM



Ideal for use with any smaller speaker system to dramatically increase the bass response.
Power handling: 50W RMS
Impedance: 4 ohms
Freq Resp: 36-200Hz
Size: 437Wx180Hx300Dmm
For details see previous ads

Cat: CS-2500
WAS $179.50
FOR JANUARY $159.50

LOWER PRICES ON COMPUTER DISKS

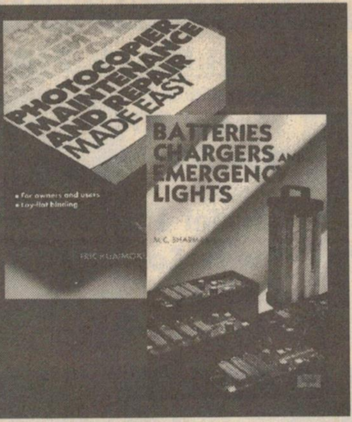
YOU WON'T BUY CHEAPER!
Lifetime Guarantee, white box.

5.25" DSDD	Cat. XC-4730/Pkt 10	**$4.50**
5.25" DSHD	Cat. XC-4732/Pkt 10	**$8.50**
3.25" DSDD	Cat. XC-4736/Pkt 10	**$8.50**
3.25" DSHD	Cat. XC-4738/Pkt 10	**$12.95**
IBM FORMATTED		
5.25" DSHD	Cat. XC-4733/Pkt 10	**$9.95**
3.25" DSHD	Cat. XC-4739/Pkt 10	**$14.95**

THE LATEST BOOKS

SEE PREVIOUS ADS FOR DETAILS

BT1380	Photocopier Maintenance and Repairs Made Easy	$32.95
BT1378	Basic Electronics Theory	$49.95
BM2484	Batteries, Chargers and Emergency Lights	$19.95
BT1374	Best Mac Tips Ever	$39.95
BT1376	Making Printed Circuit Boards	$39.95
BW3508	Ray Tracing Creations	$79.95
BW3512	Making Movies On Your PC	$69.95
BW3510	Virtual Reality Creations	$69.95
BW3504	Virtual reality Playhouse	$47.95
BX3900	Electronic Devices and Circuits	$56.95
BX3902	OP Amps with Linear IC's	$46.95
BX3904	Intro Circuit Analysis	$57.95
BM2144	Supercharging MS-DOS	$12.95
BM2128	The Norton Utilities	$7.95
BM2142	Learn Microsoft Word Now	$19.95



CRO BARGAINS FROM JAYCAR

20Mhz Dual Trace CRO

TWO FREE CRO PROBES SUPPLIED WITH EVERY PURCHASE - VALUE $79.00

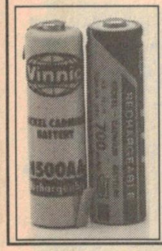
Cat: QC-1900 **Only $699**

6.4Mhz CRO was $379 now $349 save $30

WARRANTY 1 YEAR

Cat: QC-1908

AA NICAD BATTERIES



700mAh with solder tags - Cat. #: SB2451
$3.75 each

500mAh rechargable - Cat. #: SB-2452
4 for $10.00

500mAh with solder tags - Cat. #: SB2453
$2.95 each

700mAh rechargable - Cat. #: SB2450
$3.50 ea or 4 for $12.50

UPGRADE YOUR MIDRANGE

Quality white cone. see catalogue. Power handling 80WRMS system. Frequency response: 350Hz to 5.5kHz.
Cat: CM-2080

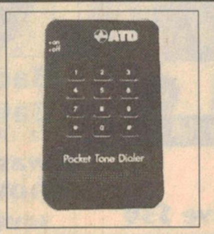
Was $28.50, Jan $20

NEW RB ELECTROLYTICS

We have increased our range of large capacitance RB electrolytic capacitors. New values are:-

Cat	Capacitance	Voltage	Price
RE6241	2200uf	50v	$3.50
RE6244	4700uf	25v	$3.25
RE6242	3300uf	50v	$4.95
RE6245	4700uf	50v	$5.95
RE6247	10,000uf	25v	$6.95

TELEPHONE TONE DIALLER BARGAIN



GENERATES DTMF SIGNALS

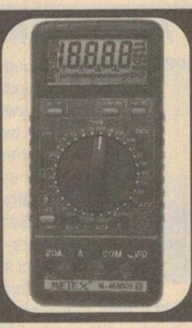
For use in conjunction with telephone answering machines, remote banking, computers, electronic voice mail and call diverters. Was selling for $19.95. Now an amazing half price. This product is not Austel approved.

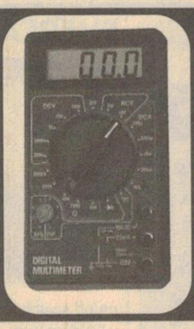
Cat: YT-6155 **Was $9.95 January $5.00**

METEX 4.5 DIGIT RS232 DIGITAL MULTIMETER SALE

Features:
•Bargraph •Frequency •Transistor •Logic •Relative Offset •20 Amp Current •Carry Case •Overload Protection •Data Hold •Min/Max Hold •Diode and Continuity •Range Selector Beeper. - See catalogue for full details.
Cat. QM-1460

Was $269.50 January Special $239.50 Save $30





LOW COST DMM REDUCED EVEN FURTHER

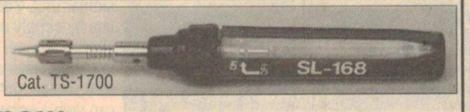
Features: •3.5 digit 12.5mm LCD display •Transistor test •Diode test •10 amp current •Plug in leads. Full feature meter with plug in 4mm probes and transistor tester for under $30!!! This is the ideal first multimeter, and will give years of faithful service.
Cat. #: QM-1500

Was $34.95 Only $29.95

SAVE ON HOTSOL GAS SOLDERING IRONS

Hot-Sol Iron

See catalogue for details. Standard HOTSOL with 2.4mm soldering tip.

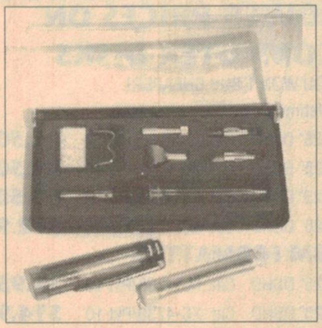


Cat. TS-1700

was $38.95 now $32.95 save $6

Hot-Sol Service Kit

This kit includes the same soldering iron as above, but comes with a range of accessories and it's all housed in its own case. Includes:
- •Hot-Sol Butane Gas Tool •Protective Cap
- •Non-slip stand with sponge •Torch Tip which gives a flame •2.4mm Soldering Tip
- •Hot Blow Tip for shrinking heatshrink
- •Scoop for feeding tubing to hot blow tip •Hot Knife Tip •Roll Solder
- •Case which holds everything

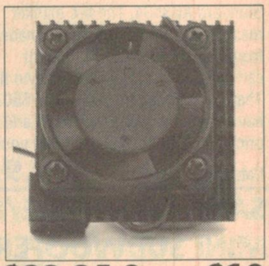


Cat. TS-1702 **was $64.95 now $49.95 save $15**

CPU COOLER REDUCED

REVIEWED IN ELEC AUST - 9/93

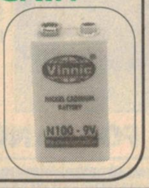
Is your 486 running too hot? Do you live in the hotter areas of Australia? Many CPU's run too hot. With our new CPU cooler you can forget all that. The CPU cooler is easy to mount, you don't need to remove the CPU. It incorporates a heatsink which clips over the CPU and is held there by a special clip. It's supplied with a piggyback plug arrangement for power. Simply unplug the power connector inside and plug the CPU cooler in-line. Installation should take all of about 3 minutes.



Cat: XC-5040 **Was $39.95 Now $29.95 Save $10**

9 V RECHARGEABLE BATTERY BARGAIN

Normally $19.95
January $15.00
Save $4.95
Cat: SB-2458



JAYCAR RESELLER WANTED IN PERTH
Please call our Wholesale Department on (02) 743-5222

Construction Project:

'World First' Night Viewers

These two night viewers are of a type that have never been available before as a construction project. There's a 'second generation' viewer and a very sophisticated first generation type that uses a tube made in Russia. They have a gain many times higher than those previously described, yet at a fraction of the cost you'd otherwise pay.

by PETER PHILLIPS

Regular readers might remember the very first IR Night Viewer project from Oatley Electronics, published in *EA* for May 1990. Despite its comparatively low gain, its popularity was overwhelming and Oatley Electronics have gone on to become well known as specialists in this technology. Not surprisingly, the viewers being described here are also from Oatley Electronics.

I'll explain what's meant by the terms *first generation* and *second generation* night viewer shortly, but first a quick look at the two projects.

As the photos show, the two projects are quite different. The viewer in Fig.1 uses a second generation tube, and the only electronics you add is a 3V battery and a switch. Otherwise, you assemble the machined case as supplied in the kit. This type of tube is normally far too expensive for most people, and Oatley Electronics really have a scoop with these.

WARNING!

The power supply in this article produces an output voltage of 13kV (kilovolts) and can give you a nasty shock. Always make sure the power is turned off and the capacitors are discharged before handling the PCB.

The other viewer, shown in Fig.2, uses a first generation tube made in Russia and needs a high voltage power supply. This viewer is actually half a binocular, so there's no mechanical construction required. It comes complete with a lens, unlike the first where a lens has to be purchased separately. These tubes are so highly developed they almost equal the performance of a second generation tube, and have only recently become available.

Construction of either viewer is quite easy, as the electronics for the Russian viewer is all mounted on a silk-screened PCB that shows where the parts go. The case of the other viewer is also easy to build, thanks to its beautifully machined construction. Before we describe how to build them, first a look at what a night viewer is...

Fig.2: Fitted with a sensitive first generation tube made in Russia, this night viewer needs a high voltage supply. This is simple to build and fits inside the plastic case which then clips to your belt.

Complete viewer

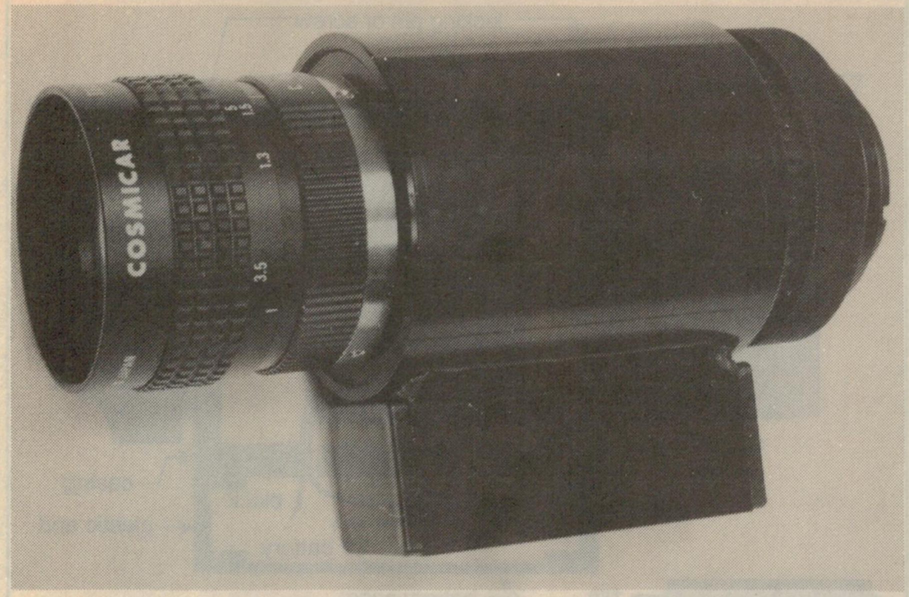
The basic construction of a complete night viewer is shown in Fig.3. The main part of the viewer is the *image intensifier* tube and because it's the most complex part of the whole assembly, we'll describe it separately.

The input lens fits at the front of the case and its function is to focus the scene being viewed onto the cathode of the image intensifier tube. Therefore the lens serves the same purpose as in a camera and the type of lens is chosen for the application, just as it would be for a camera. You can have a wide-angle lens for close-up work, a telephoto lens for distance viewing or even a zoom lens.

The eyepiece is usually a simple magnifying lens which magnifies the picture on the screen (anode end of the tube). If the eyepiece is removed, the screen of the image intensifier tube can be photographed or even videotaped.

Image intensifier tubes need a very high voltage to work, often as high as 15kV. However the current taken by the tube is very small, so the power supply doesn't need to deliver much current. This makes it relatively safe, as it can't deliver a lethal current. However, you can still get a nasty shock, so you need to be careful.

The power supply is therefore a DC to DC converter, powered from batteries. Some tubes, including that in the viewer shown in Fig.1 have the power supply



built in, and all you add is the battery. Otherwise, a separate high-voltage power supply is required.

Image intensifiers

An image intensifier is an electron-optical device in which the image of a scene focused onto a photocathode is intensified and displayed on a luminescent screen. The photocathode is intentionally sensitive to both luminous and infrared light. The luminescent screen is viewed directly and is coated with a green (usually type P20) phosphor because the eye is particularly sensitive to this colour. Therefore these tubes produce a black and green picture which can have a similar definition to that produced by a video camera.

However a night viewer is many thousands of times more sensitive than a video camera, which means it produces a discernible image in light conditions approaching almost complete darkness.

The unit of light intensity is the lux, and the typical recommended illumination for a video camera is around 100 lux. These days, some video cameras can operate down to as low as three lux, and up to 100,000 lux.

Contrasting this with the specifications of an image intensifier tube shows just how sensitive these devices are. Philips recommend a *maximum* level of 10 millilux (10mlx or 0.01 lux) for their tubes, pointing out that the life of a tube is reduced with prolonged exposure to this light level. At 1mlx, the minimum life is 2000 hours and at 100 microlux (0.0001 lux), the minimum life is 5000 hours. So you can get an idea of what these figures mean, Table 1 lists light levels you're familiar with, along with the light intensity in lux.

The sensitivity of a night viewer is its most important specification. An average viewer has a sensitivity of 10mlx, making it useful in 'quarter moon' lighting. A sensitive viewer can operate at 1mlx, or in starlight conditions. For this reason, these viewers are often called 'starlight' viewers. The two viewers described here have tubes that qualify as starlight viewers, especially the viewer with the second generation tube.

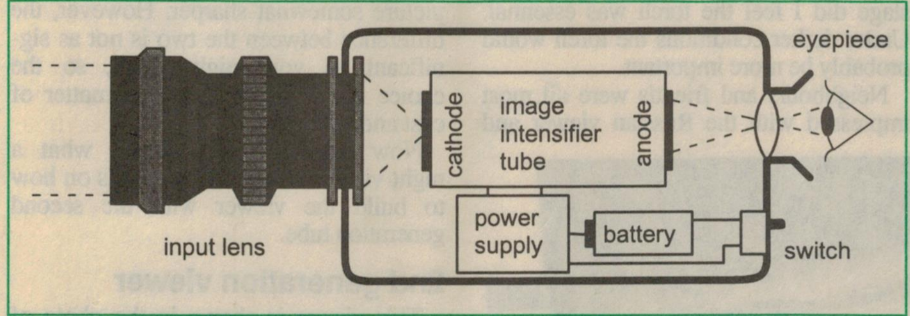


Fig.3: The component parts of a night viewer include the input and output lens, the image intensifier tube and a power supply all fitted in a case.

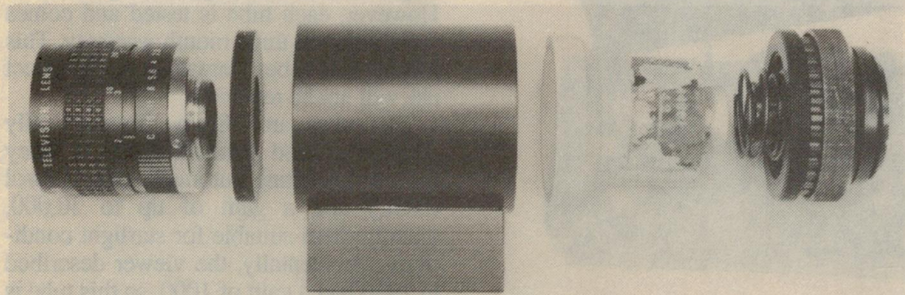


Fig.4: This photo gives an 'exploded' view of the case for the second generation night viewer. The eyepiece (on right) is shown screwed into the end of the case, unlike the input lens which is positioned ready to screw into the other end.

IR sensitivity

A feature of an image intensifier is its sensitivity to infrared (IR) light. By illuminating a scene with an IR light source, it becomes almost as bright as day through the viewer, but appears otherwise to be in darkness.

The first night viewers (produced during World War 2) relied on high power IR light sources, and were called 'active' night viewers. The main problem for the military is that the IR light is visible to the enemy if they also happen to have a night viewer.

The viewers described here can operate without an IR light source, but the visibility of the scene is enhanced under very low light conditions if it's lit with a low power IR light source. This is called 'IR assisted', compared to an active night viewer where the IR light is essential.

For instance, I found I could quite easily read a book in total darkness through the viewer in Fig.1 when I used an IR light. Otherwise, the outline of the book was visible, but the text indiscernible.

An IR light source is easy to build, as all you need is a torch (like a Maglite) with an IR filter over the front. IR LEDs can also produce usable amounts of light, although not as much as an incandescent light.

Types of tubes

Image intensifier tubes are basically categorised as first, second or third generation types. Third generation tubes

Night Viewers

are improved versions of the second generation type and have a higher gain. Otherwise, they're similar to a second generation tube.

The difference between the first and second generation tubes is that a second generation type has an electron multiplier built into the tube, which gives them higher gain. The multiplier is called a *microchannel plate*, which extends from the cathode to the anode inside the tube.

Most second generation tubes also have the power supply built into the body of the tube, and feature automatic gain control and automatic brightness control. They usually come prefocused and many have a fibre-optic output window.

Except for the microchannel plate, first generation tubes can also have all these features. Their gain is therefore less than for a second generation tube. One method of increasing the gain with first generation tubes is to cascade them, in which the image produced by the first is focused onto the next, which passes the amplified image onto a third tube. This arrangement gives a high sensitivity, but a large physical size.

Some first generation tubes require a focus voltage, like a TV picture tube. Others (like the Russian tube) come prefocused.

The projects

You're probably concluding that the best viewer here is the one with the second generation tube. It's difficult to adjudicate, as the sample viewers supplied for this article have different lenses.

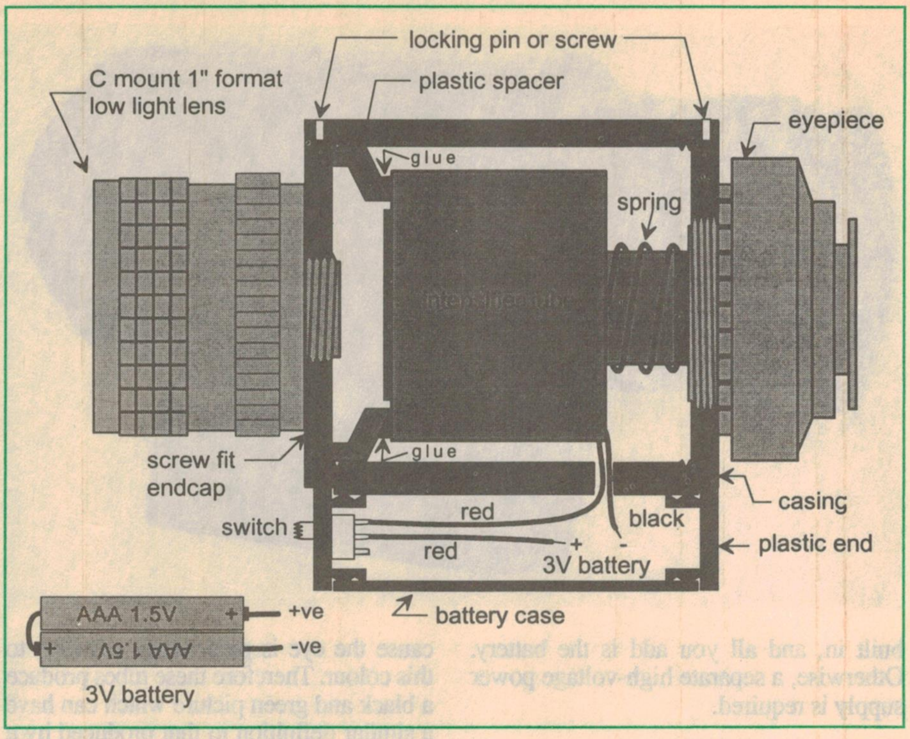


Fig.5: This drawing shows how the case for second generation the night viewer is assembled. Use silicone glue to attach the plastic spacer to the tube.

The lens of the Russian viewer is focused to infinity, making it useful for viewing a scene beyond a few metres. Any closer gives a blurred image.

With this viewer I was able to clearly see objects more than 100 metres away in almost starlight conditions. Using the IR torch increased the visibility, but at no stage did I feel the torch was essential. Under darker conditions the torch would probably be more important.

Neighbours and friends were all most impressed with the Russian viewer and expressed an immediate desire to have one. When I showed them the viewer with the second generation tube, some felt the Russian viewer was better. However, I suspect the close-up lens fitted to this viewer made the difference.

Certainly, I found the second generation viewer more sensitive and the picture somewhat sharper. However, the difference between the two is not as significant as you might think, so the choice of viewer is largely a matter of cost and availability.

Now that we've explained what a night viewer is, here's the details on how to build the viewer with the second generation tube.

2nd generation viewer

This viewer is shown in the photo of Fig.1. The image intensifier tube that will be supplied in the kit is second-hand and might have a minor optical imperfection. However, each tube is tested and comes with a limited three month warranty. This means that tubes damaged by incorrect use will not be replaced.

The tubes are 18mm, fibre-optically coupled second generation types. They have a fast-acting automatic gain control (AGC) and a gain of up to 30,000, making them suitable for starlight conditions. (Incidentally, the viewer described in 1990 had a gain of 1000, so this tube is some 30 times more sensitive.)

Because the power supply is integral with the tube (which measures a very

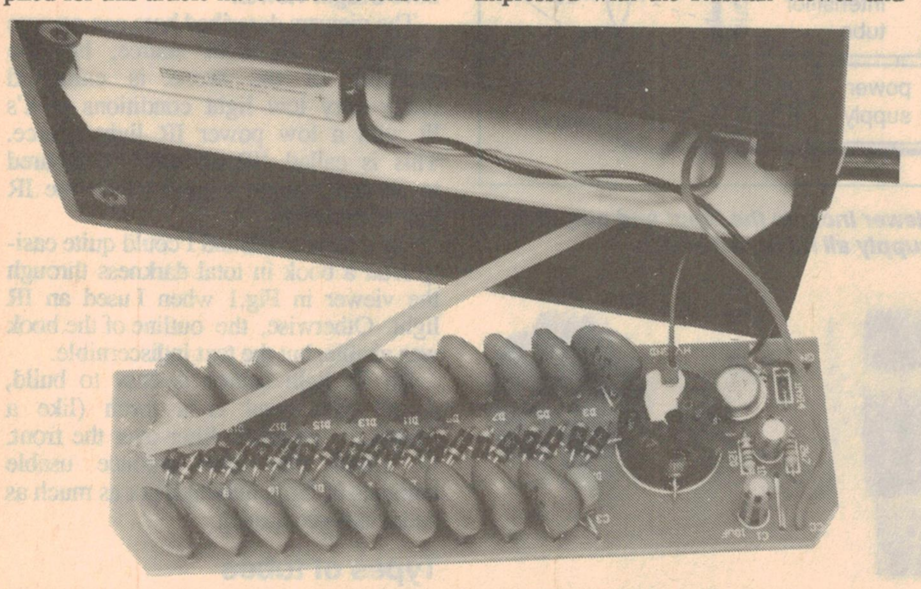


Fig.7: This photo shows a close-up of the PCB for the high voltage power supply used for the Russian viewer. Secure the coaxial cable with a dab of silicone glue at its connection point on the PCB.

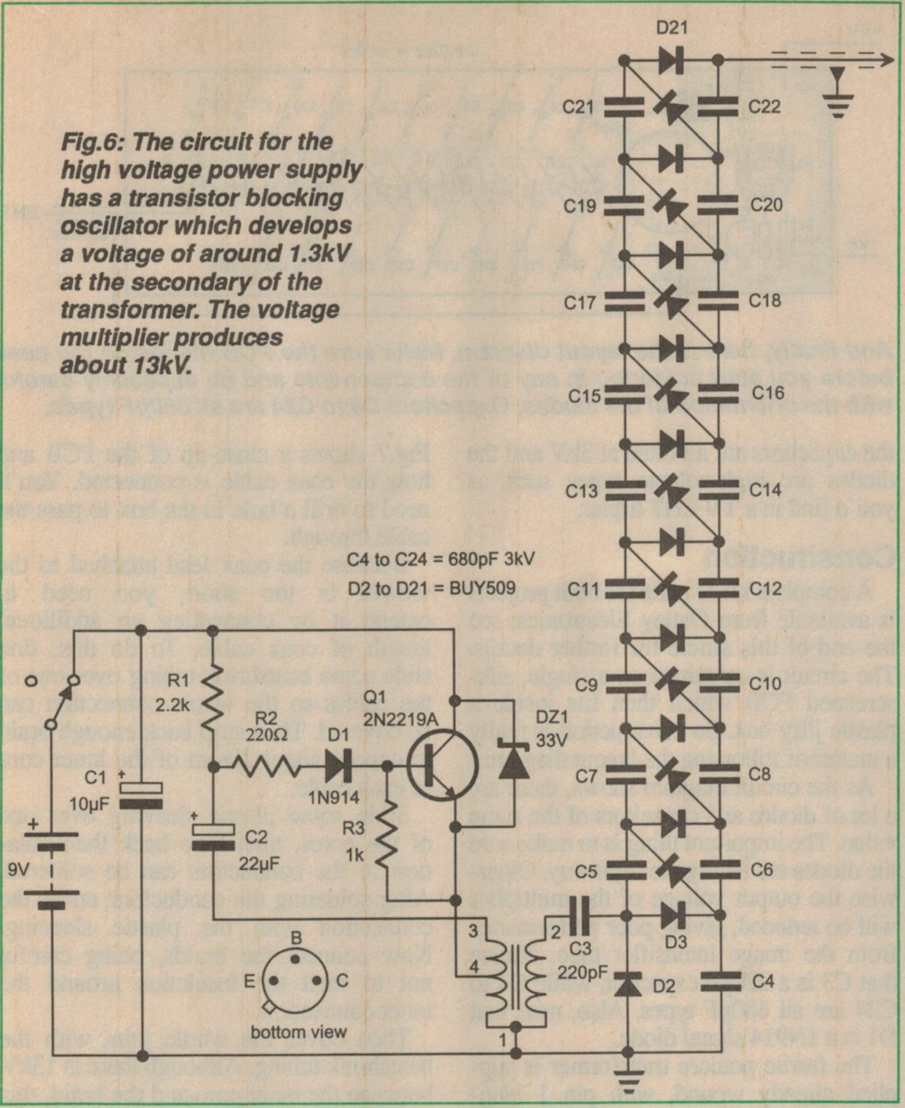


Fig.6: The circuit for the high voltage power supply has a transistor blocking oscillator which develops a voltage of around 1.3kV at the secondary of the transformer. The voltage multiplier produces about 13kV.

small 43mm diameter by 40mm long) the only electrical addition is a 3V battery and a switch. The technology used in these tubes is quite awesome, and they are probably one of the most sophisticated devices ever made.

The photo of Fig.4 shows an exploded view of the case and Fig.5 shows how it is assembled. You'll need to drill a hole in the case and in the battery housing for the wires to the tube. After the hole is drilled, glue the battery housing to the case with an epoxy glue. While that glue is setting, glue (with silicone glue) the spacer to the intensifier tube. This spacer holds the tube central inside the case and butts against the input lens end of the case. Next drill a hole in one of the plastic endcaps of the battery housing to take the switch. The switch is then glued to the endcap and the wires soldered as shown in Fig.5.

Finally assemble the whole thing. The ends of the case are a screw fit, and you'll need to lock them in place with a pin or lock screw as shown in Fig.5.

The eyepiece assembly has a spring that presses against the intensifier tube, pushing it towards the front of the case. It also has a spring loaded lens that should contact the screen of the tube. Check that this lens is free to move, and if necessary free it with a small screwdriver.

It was originally intended to power the tube with two N-size cells, fitted in an N-size battery holder. The case was therefore designed for this type of battery. However, at the time of writing, N-size battery holders have become difficult to obtain, although they might be available when this article is released.

So until these holders are available, use two size AAA 1.5V cells soldered in series. The larger AA size cells won't fit inside the case, and neither will a battery clip for the AAA cells. All you do is solder the leads to the cells, by first linking the positive end of one cell to the negative end of the other.

Then solder the black wire from the intensifier tube to the negative terminal of the battery pack and the positive wire from the tube to the common contact of the switch. The normally-open contact of the switch then connects to the positive terminal of the battery.

By the way, the leads from the tube are teflon insulated and are therefore difficult to strip. Use a sharp knife (or a razor) rather than wire strippers. As a check, when you switch on the power to the tube, the current drain should be around 14mA.

The input lens is a matter of choice, and lenses will be available from Oatley Electronics. The lens used in the prototype is a 50mm f/1.4 Cosmicar brand, type number B5014A. A telescopic Cosmicar lens type B7514C can also be used.

Once it's all assembled, the screen of the tube should light up (a green colour) when power is switched on. Note that if there's no light reaching the input end of the tube, the screen won't light.

The eyepiece lens is then adjusted so you can see the grain of the phosphor screen. This setting will vary between users. Otherwise, it's simply a matter of putting the viewer to use, as explained later in this article.

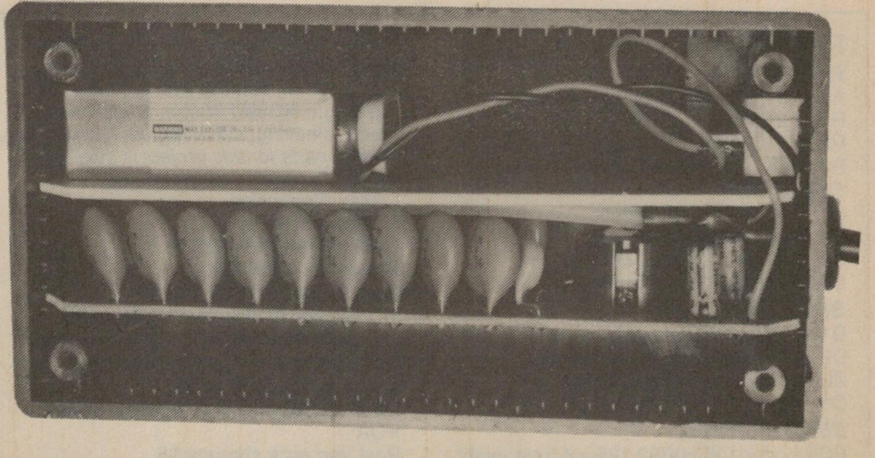


Fig.8: This is how everything fits inside the case. The plastic spacer stops the battery case touching the high voltage capacitors.

The Russian viewer

Construction of this viewer is virtually all electronic. The viewer itself is mechanically complete, and simply needs a high voltage to make it work.

The circuit of the supply is shown in Fig.6 and has an oscillator that produces around 1.3kV at the secondary of the transformer and a 10-stage Cockroft-Walton multiplier. The output of the multiplier is about 13kV.

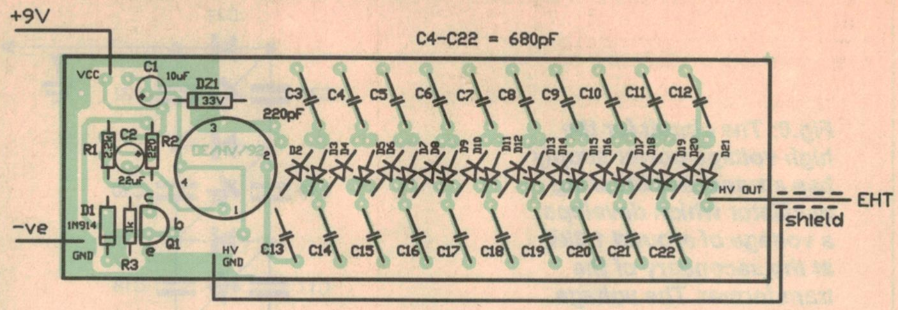
When power is first switched on the transistor conducts, as it's forward biased by R1, R2 and D1. Therefore the supply voltage of 9V is applied to the centre-tap of the transformer and current starts to flow in the primary winding. By transformer action, the voltage at pin 3 of the transformer will be higher than 9V, which is coupled via C2 to the base of the transistor, making it conduct even harder.

When the current stops increasing, transformer action ceases and the positive feedback from pin 3 stops. The transistor starts to turn off and the voltage at pin 3 drops, discharging C2 and making the transistor switch off very quickly.

The cycle then repeats, giving a square wave of approximately 10kHz at the primary of the transformer. This is stepped up to some 1.3kV by the secondary of the transformer, rectified and further stepped up by the voltage multiplier.

The Cockroft-Walton voltage multiplier works by charging each stage to 1.3kV. Because it's taken from the top of the 'stack', the final voltage is the sum of each stage. As there are 10 stages, the output voltage is 13kV.

This type of voltage multiplier can only supply a very small current, and the capacitors and diodes have to be rated to withstand at least 1.3kV. For this reason, the capacitors are all rated at 3kV and the diodes are high-voltage types such as you'd find in a TV EHT tripler.



And finally, here is the layout diagram. Make sure the PCB fits inside the case before you start soldering in any of the components and be especially careful with the orientation of the diodes. Capacitors C4 to C24 are all 680pF types.

Construction

A complete kit of parts for both projects is available from Oatley Electronics; see the end of this article for further details. The circuit is contained on a single, silk-screened PCB which then fits inside a plastic jiffy box. So construction is really a matter of following the layout diagram.

As the circuit diagram shows, there are a lot of diodes and capacitors of the same value. The important thing is to make sure the diodes are facing the right way. Otherwise the output voltage of the multiplier will be reduced, giving poor performance from the image intensifier tube. Notice that C3 is a 220pF capacitor, while C4 to C24 are all 680pF types. Also, note that D1 is a 1N914 signal diode.

The ferrite potcore transformer is supplied already wound, with pin 1 identified. Simply install it and solder it in place. As usual, make sure the two electrolytic capacitors are installed with the right polarity.

Once the board is assembled, it remains to connect the 9V battery clip, the switch and the coaxial cable that supplies the high voltage to the viewer. The photo of Fig.7 shows a close-up of the PCB and how the coax cable is connected. You'll need to drill a hole in the box to pass the cable through.

Because the coax lead attached to the viewer is too short, you need to extend it by connecting an additional length of coax cable. To do this, first slide some heatshrink tubing over one of the cables so the whole connection can be covered. Then strip back enough braid to expose about 20mm of the inner core of each cable.

Slide some plastic sleeving over one of the cores, then bare back the insulation so the conductors can be soldered. After soldering the conductors, cover the connection with the plastic sleeving. Now connect the braids, being careful not to melt the insulation around the inner connection.

Then cover the whole joint with the heatshrink tubing. Although there is 13kV between the inner core and the braid, this method of joining the cables is adequate providing there's at least 1mm or so of plastic insulation between the inner conductor and the braid.

To connect the coax to the PCB, first strip the braid back to expose a sufficient length of the inner core. Then cut the braid so there's enough left to allow a length of hook-up wire to be soldered to it. This wire then connects to the common of the PCB as shown in the layout diagram. The inner core connects to the EHT output of the board. After soldering this connection, dab some silicone glue around the lead to hold it in place.

As the photo of Fig.8 shows, the assembled PCB slots into the plastic case. A sheet of 2mm plastic, cut to size, is then placed against the PCB to give a compartment for the battery. This is done to prevent the battery case contacting the high voltage capacitors.

Cut some foam to fit inside the battery 'compartment' to stop the battery moving around in the case. Incidentally, we recommend an alkaline type for the 9V battery.

PARTS LIST

Resistors

All 1/4W, 5% unless otherwise stated:

- R1 2.2k
- R2 220 ohm
- R3 1k

Capacitors

- C1 10uF 25V electrolytic
- C2 22uF 25V electrolytic
- C3 220pF 400V AC ceramic
- C4-22 680pF 3kV ceramic

Semiconductors

- D1 1N914 signal diode
- D2-21 BY509 high voltage diode
- ZD1 33V 0.3W zener diode
- Q1 2N2219 NPN transistor

Miscellaneous

PCB coded OE/HV/92 125 x 41mm; night viewer as described; prewound potcore transformer; plastic case 130 x 70 x 45mm; 9V battery and snap connector; plastic rocker switch; 2mm thick plastic, 125 x 41mm; belt clip with adhesive back; 1m length RG59U 75ohm coaxial cable; plastic sleeving; silicone glue; hookup wire.

A kit of parts for this project is available from:

Oatley Electronics
5 Lansdowne Parade,
Oatley West, NSW 2223.
Phone (02) 579 4985
Postal address (mail orders):
PO Box 89, Oatley West NSW 2223.

Complete kit for Russian IR viewer: $550
Case and second generation image intensifier tube: $380 to $580
Lens to suit second generation viewer: POA
Post and pack charges $5

The circuit and PCB designs for this project are copyright to Oatley Electronics.

Table 1

direct sunlight	100,000 lux
bright sunlight	10,000 lux
overcast day	1,000 lux
very dull day	100 lux
twilight	10 lux
deep twilight	1 lux
full moon	0.1 lux
quarter moon	0.01 lux or 10mlx
starlight	0.001 lux or 1mlx
overcast starlight	0.0001 lux or 100μlx

Testing

Once you're sure everything is ready to go, switch on the power supply. The current consumption should be around 25 to 30mA. You might hear a 10kHz whistle from the transformer, depending on your hearing and the transformer.

If all is well, the screen of the viewer should glow a greenish colour (with or without light input to the viewer). By the way, you'll probably find the screen remains lit for a few minutes after the power has been switched off, indicating there's still sufficient voltage for the tube to operate. For this reason, don't touch the power supply until you're certain the capacitors are all discharged.

Using the viewers

There are a number of important things to mention about both viewers. Firstly, the life of an image intensifier tube will be shortened if it's exposed to bright light for too long. Don't use the viewer in sunlight, or even in a well lit room. It's also a good idea to store a night viewer so the tube is in darkness.

You'll need to experiment with the focusing of the eyepiece on both viewers. This is the only optical adjustment on the Russian viewer and should be set to give the sharpest image. Neither of these viewers can operate in complete darkness, although you'll get surprisingly good images in very low light conditions. An IR torch will enhance the image considerably.

Although the typical use for a night viewer is 'to see in the dark', another use is to check the output of an IR remote control. When the business end of an IR remote control unit is looked at through a night viewer, you should see a pulsing light when a key is pressed. You'll also be able to compare the power output of different remote controls after you've experimented with a few types. And if you need a low power source of IR light, you might even try a remote control! ❖

Construction Project:

PC PROGRAMMER FOR 68705 MICROCOMPUTERS

Here's a new design for a device to program 68705 single-chip microcomputers. It can interface to a wide range of computers for essentially 'direct' program downloading, thanks to a standard RS-232C serial port, but is also capable of independant operation for programming from an EPROM. It is fully compatible with the Motorola S19 file format, as used by virtually all compilers for downloading from a PC.

by DAVID RUSSELL and PAUL WILLIAMS

Recently there has been an increasing number of projects appearing in electronics magazines using 68705 single-chip microcomputers. These devices are very versatile, easy to program and best of all they are a lot of fun to use!

The 68705 family of microcomputers are basically a complete computer in one chip, consisting of the CPU, RAM, EPROM for user programs (1.8K for the P3 version, 3.8K for the R3/U3 versions), a timer with prescaler, bidirectional input/output lines (20 on the P3, 24 on the R3/U3), plus eight unidirectional input lines on R3/U3, external interrupt lines (one on the P3, two on the R3/U3) and an A/D converter, with four separate multiplexed inputs on the R3 version. They run off a single +5V supply, and all the above features are fully software controllable by the user's programs.

The usual method of programming a 68705 chip is to firstly write the program (either in assembly language, and compile it, or directly in machine code), then program an EPROM with the program, plus vector locations.

Once this is done, a programmer, such as the one described in the *M6805 HMOS/M146805 CMOS Family User's Manual* is used to transfer the program from the EPROM into the EPROM memory area of the 68705 chip itself.

While this method of programming works well, it is a long and drawn out process which requires you to have an EPROM programmer. This in itself can be quite an expensive piece of equipment, and not something that is readily accessible to all people.

This project eliminates the need to use EPROMs to program the 68705 microcomputers, by using an on-board RAM. This allows the 68705 to be pro grammed directly from the user's software, written on any computer. The assembled program is downloaded to the RAM via the serial port of the computer, and then programming starts automatically.

Any computer can be used, provided that you have access to a suitable 6805 cross-assembler program, capable of generating Motorola S19 output files; and it has a serial port that can produce RS-232C format at 9600bps with eight data bits, one stop bit and no parity.

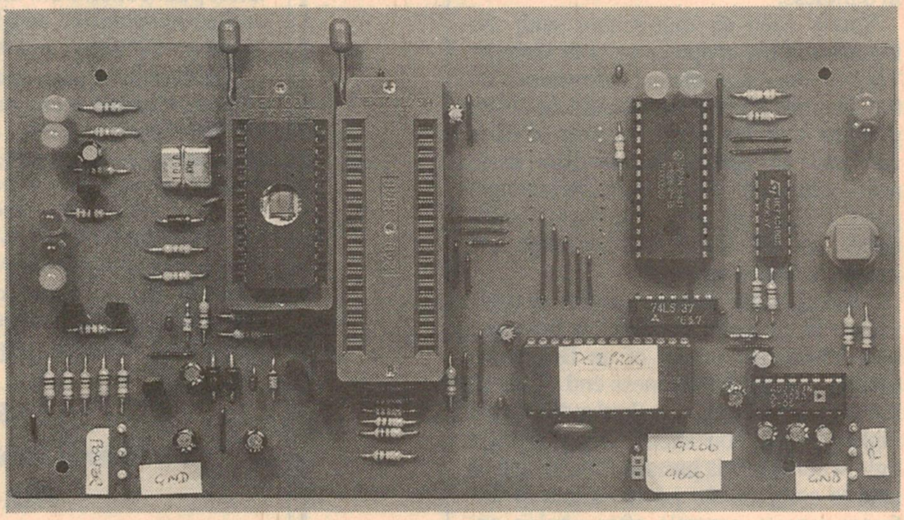
Provision has also been made for programming from EPROM's, if there is the need. For example people with existing software on EPROM can use the programmer in 'free standing' mode, without the need for a PC.

Our programmer uses a 68705P3 device as its own on-board controller (IC6), pre-programmed with software to control the on-board RAM, serial transfer of files from a computer to the programmer, the selection of either RAM or EPROM programming, and controlling the supply rails and reset line to the 68705 device being programmed. Numerous LEDs display the status of both the programmer and the 68705 uP being programmed at all times.

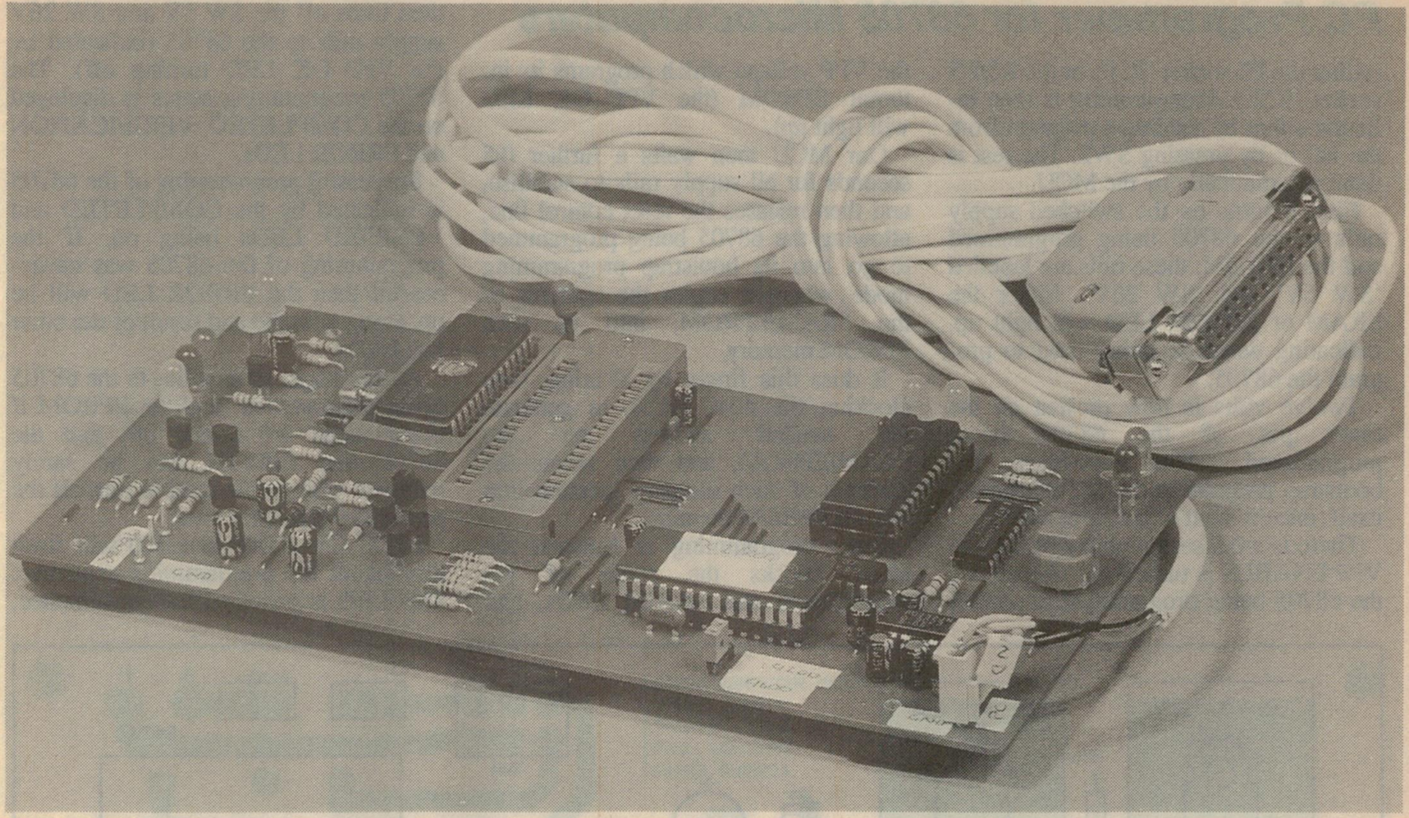
Features

The main features of this programmer can be summarised as:

- Programs 68705P3/R3/U3 devices, from the on-board SRAM (when software is down loaded from the PC), or directly from EPROM. Both

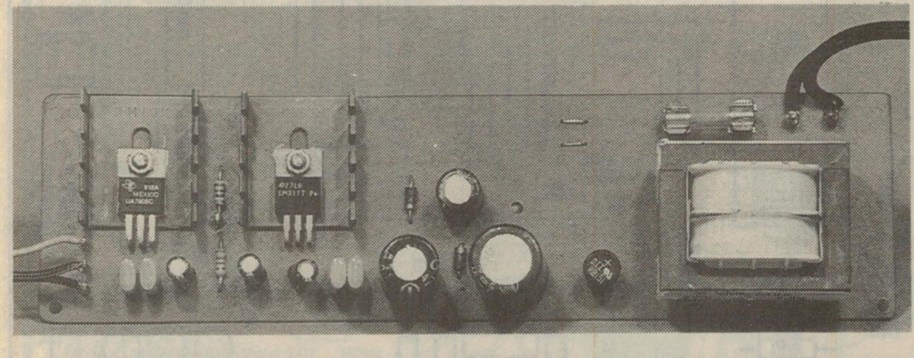


Use this photo of the main PCB for the programmer as a guide to assembly, in conjunction with the overlay diagram. Note that when this was taken, IC6 was operating with a single capacitor in its clock oscillator, rather than a crystal.



methods can be controlled from the PC, or EPROM programming can be done without the use of a PC (stand alone mode).

- Uses the Motorola S19 data file format, standard on almost every compiler, for transfer of files from PC to programmer.
- On-board MCU (microcontroller unit) checks and clears the SRAM on power up; checks that the data coming from the PC is correct; then writes the data into the SRAM.
- Controls the reset line and power supply rails to both the microcomputer being programmed and the EPROM. Power is turned off automatically to the 68705 and EPROM sockets when programming is over.
- Nine LEDs display the status of programmer at all times, indicating the following conditions:
  1,2: +5V and switched +21V supply rails OK.
  3,4: SRAM or EPROM programming.
  5: The ability to accept data from the PC (CTS LED).
  6: Detection of programming or data transfer errors (ERROR LED).
  7: Local address bus activity (ADDR-2 LED).
  8: When programming has finished (COMPLETE LED).
  9: That programming has been successful (VERIFIED LED).
- Minimal use of PC processor time is required to control the programmer.



Here's a photo of the assembled power supply board, again to guide you when constructing your own. A pair of wire links were fitted to the PCB in place of power switch SW1 when this was taken. This board must be fully enclosed.

The PC is only required to download the assembled S19 file to the programmer, then the programmer does the rest. This allows the PC to be used for other tasks while programming is in progress, which can take up to 3.5 minutes.

A link is provided on the programmer PCB, originally with the idea of providing an optional higher speed of 19.2kbps for the serial interface.

However the authors would be happy to receive suggestions from readers, as to any other optional feature they would prefer.

Operation

When the Programmer has been connected to the PC and the power is applied, our MCU (IC6, a pre-programmed 68705P3) runs its health checks — which include testing the static RAM (IC4) for stuck bits and cross-linked memory locations, and also checks the integrity of the address bus. All locations of the SRAM are then cleared by writing into them with 00hex.

When this is complete, the CTS LED will come on, thus indicating that 68705 programmer is ready for use. If there is an error during the health checks, the SRAM and ERROR LED's will come on and stay on, and all programmer functions will cease.

The 68705 uP to be programmed is then placed in the appropriate socket

(either the P3 socket 'IC1', or the R3/U3 socket 'IC2'). Programming is then initiated either by sending a program from the PC or by pressing SW2. The rest is done automatically by the MCU.

First it turns on the switched supply rails to the 68705 being programmed and the EPROM; these rails are labelled 'SW 5V' and 'SW 26V'. Either the SRAM or EPROM LED will light up, indicating which is being used to program the 68705.

Twelve volts is now present on the timer pin of the 68705 being programmed. This activates the bootstrap program in the uP, to program itself, once it's out of the reset state.

There is a 0.5 second delay before the VPP ENABLE is turned on. This allows the 68705 being programmed to control the VPP voltage which programs its internal EPROM (the VPP OK LED will light up).

Our MCU then waits a further 0.5 seconds for all supply rails to stabilise, and then releases the reset control line, allowing the 68705 being programmed to go into its bootstrap programming mode, where it copies the contents of the SRAM/EPROM, into its own EPROM memory.

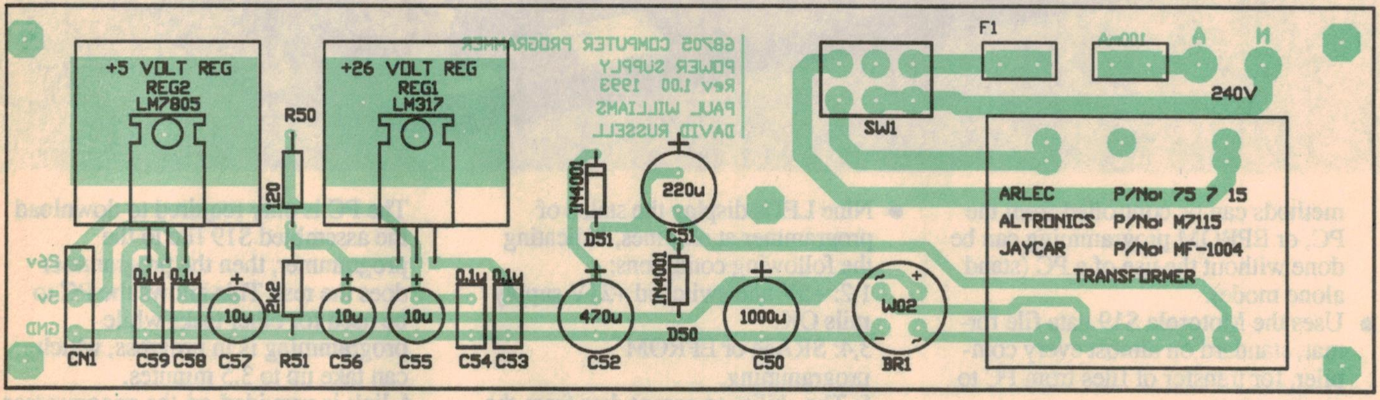
It does this firstly by clearing, then clocking the 4040 (IC5), to generate the needed address on the SRAM/EPROM, and then writes the contents of each memory location into its own EPROM memory.

Once programming is finished the MCU checks the status of the programmed and verified LEDs, and then turns off the SW 5V and SW 26V supply rails to the 68705 (indicated by the VPP OK LED turning off). The 68705 programming status is displayed on the COMPLETED, VERIFICATION and ERROR LEDs.

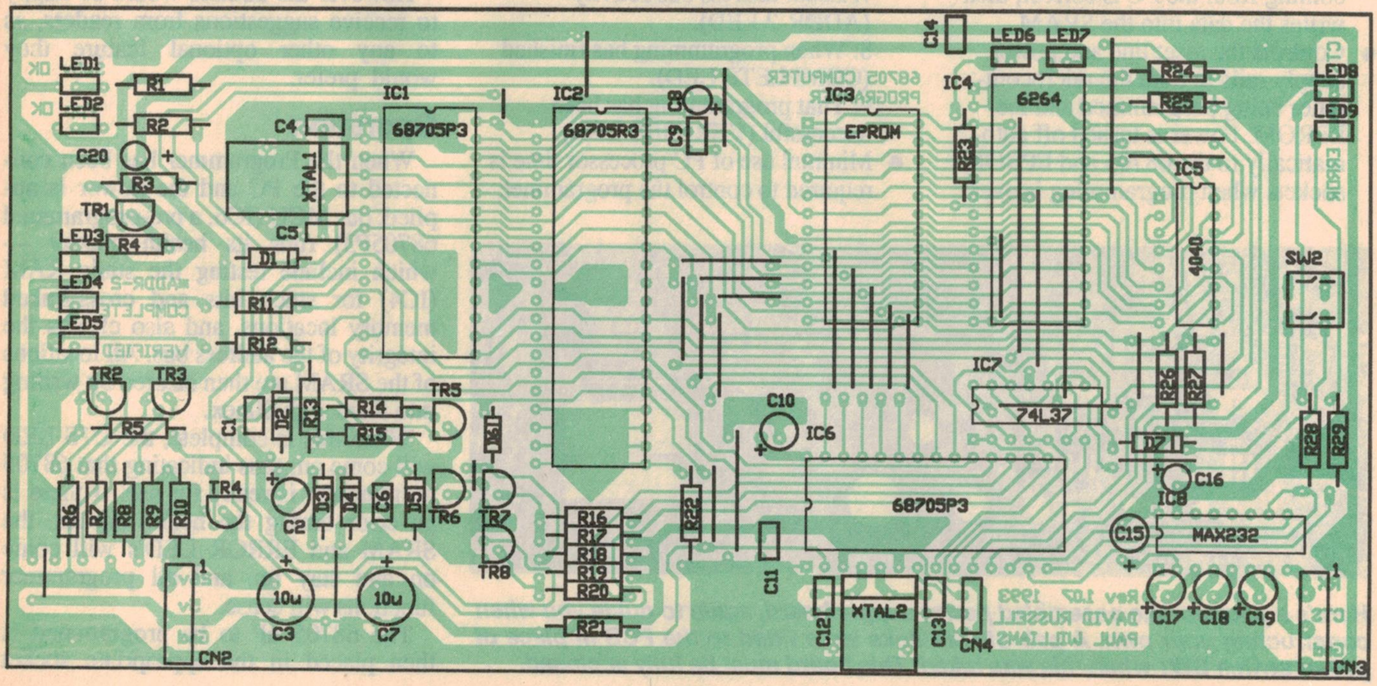
Successful programming of the 68705 is indicated by the COMPLETED and VERIFIED LEDs being on. If the programming of the 68705 was unsuccessful then the ERROR LED will be on, along with the end result of the other two LEDs.

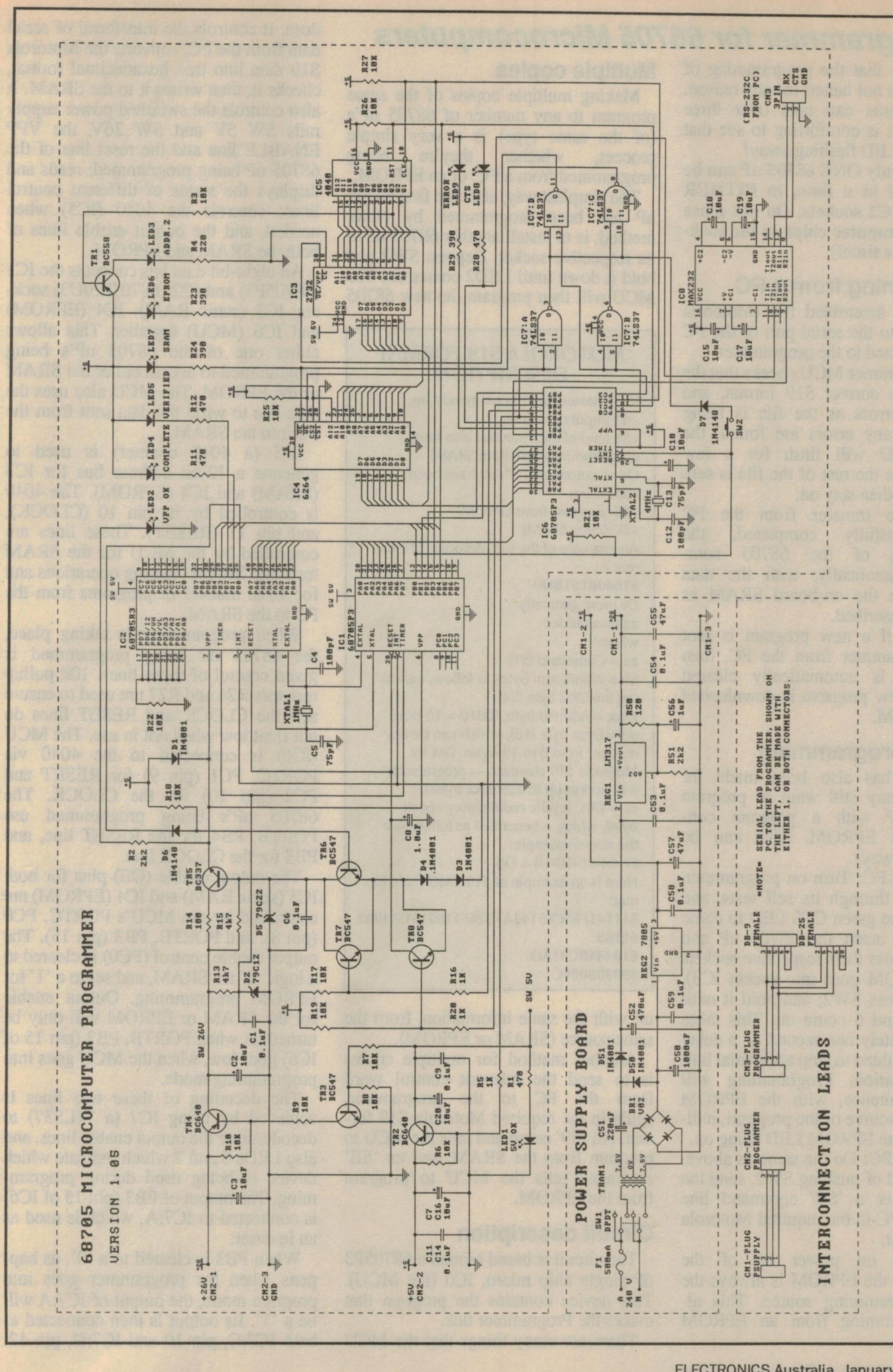
At this stage, all supplies to the 68705 being programmed (and the EPROM if being used) are turned off, and the 68705 and EPROM can be safely removed without the need to turn off the power to the programmer.

LED3 (the STATUS LED) will flash throughout the programming sequence. This LED is provided for convenience,



Above and below are wiring overlay diagrams for the power supply board and main programmer board respectively. As you can see, the main board has a number of wire links — which should be fitted before any of the other components, to make sure you don't forget them. Adding them later can be very difficult!





The complete schematic for the programmer is shown here. All of its functions are controlled by the onboard 68705P3 microcontroller (IC6), pre-programmed with appropriate firmware. IC1 and IC2 are the sockets for the device to be programmed. The author can supply pre-programmed chips for IC6 — see the parts list for details.

so you know that the programming of the 68705 has not halted for any reason. Large programs can take over three minutes, so it is comforting to see that little yellow LED flashing away!

(NOTE: Only ONE 68705 uP can be programmed at a time, in EITHER the IC1 or IC2 sockets. Do not place two microcomputer chips in the sockets at any one time!)

Programming from a PC

Send your assembled file (Motorola S19 format) to the serial port of the PC that is connected to the programmer.

The Programmer MCU checks that the file is in the correct S19 format, and checks for errors as the file is being received. If any errors are found, the ERROR LED will flash for a few seconds while the rest of the file is sent through, and then stay on.

If the file transfer from the PC was successfully completed, the programming of the 68705 commences automatically, with the data coming from the on-board SRAM as previously described.

Note that if a new program is sent to the programmer from the PC, then the SRAM is automatically cleared before the new program is downloaded into the SRAM.

EPROM programming

Provision has also been made for those who may still want to program a 68705 uP with a program contained in an EPROM. This can be done in two ways.

1. Without a PC: Turn on programmer, let it run through its self tests, and wait for the green CTS LED to come on. Then insert the 68705 uP and EPROM into their respective sockets (the EPROM goes into socket IC3). Now depress SW2, and hold it until LEDs 2 and 6 come on. This takes approximately one second — a delay has been added to stop accidental button activation. Programming will now commence, with the EPROM being the source of the program, indicated by the EPROM LED being on.
2. Using the PC: Do the same as above, but instead of pushing SW2, send the programmer a 'SE' command line from the PC in the required Motorola S19 format.

Note that on power up of the programmer, the EPROM is always the default programming source. This allows programming from an EPROM without a PC.

Multiple copies

Making multiple copies of the same program to any number of 68705 uP's (of the same type) is a very simple process, whether they're being programmed from a PC, or an EPROM.

The simplest way, after the first 68705 uP has been programmed by either method, is to install another 68705 uP in its respective socket. Depress SW2 and hold it down until LED2 comes on. The MCU will then program the new 68705 uP with the same information, from the same source (SRAM or EPROM).

Another method for multiple copies is to send the relevant control word from the PC to the programmer, again in the required Motorola S19 format. An 'S9' command tells the MCU to program from the SRAM, and an 'SE' command tells the MCU to program from the EPROM.

MOTOROLA S19 FORMAT DESCRIPTION

Valid Motorola S19 commands are:
- **S1** (input data line)
- **S9** (end of data transfer, also starts programming of uP from SRAM)

Other commands which have been added are:
- **SE** (program from EPROM)
- **SC** (clear SRAM)

An example of the full Motorola S19 format is:
S10400101BD0
Or more generally
zzbbxxxxddcc
where:
zz = Command (S1)
bb = Number of bytes to follow, including the CRC byte (04).
xxxx = Address byte, (0010 = 10 hex.)
dd = Data byte (1B), which can be any number from 0 to 19 bytes. (Set by Motorola S19 standard — programmer will accept up to 255 data bytes)
cc = CRC (cyclic redundancy check byte), which is generated as follows for the above example:
FF-04-00-10-1B = D0
Here is an example of S19 '.MOT' file format:
S111417EFC36143A1526F110015CA3032 6E169
S104418C81AD
S9030000FC

Circuit description

The circuit is based around a 68705P3 uP single chip micro, IC6 (the MCU). This device contains the program that makes the Programmer tick.

There are many things that the MCU does. It controls the transferral of serial data from the PC, converts the Motorola S19 data into true hexadecimal format, checks it, then writes it to the SRAM. It also controls the switched power supply rails SW 5V and SW 26V, the VPP ENABLE line and the reset line of the 68705 uP being programmed; reads and displays the status of different control lines; controls the 4040 (IC5) when needed, and the output enable lines of both the SRAM and EPROM.

An eight-bit data bus connects the IC1 (68705P3) and IC2 (68705R3/U3) sockets, IC3 (static RAM), IC4 (EPROM) and IC6 (MCU) together. This allows either one of the 68705 uP's being programmed to access either the SRAM or the EPROM. The MCU also uses the data bus to write the data sent from the PC into the SRAM.

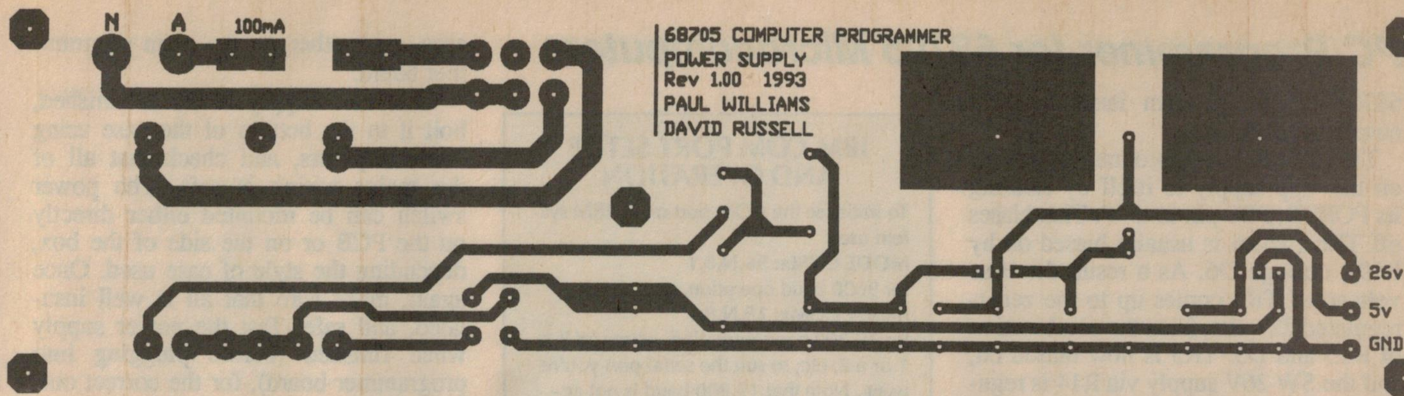
IC5 (a 4040 counter) is used to generate a 12-bit address bus for IC3 (SRAM) and IC4 (EPROM). The 4040 is controlled by its pin 10 (CLOCK), and pin 11 (RESET). These lines are controlled by the MCU for the SRAM tests, the SRAM clearing operations and for serial transfer of programs from the PC to the SRAM.

When programming is taking place, the 68705 uP being programmed is given control of these lines. 10k pullup resistors R26 and R27 are used to ensure that the CLOCK and RESET lines do not float low when not in use. The MCU (IC6) is connected to the 4040 via PORTC, PC1 (pin 9) for RESET and PC2 (pin 10) for the CLOCK. The 68705 uP's being programmed use PORTB, PB4 for the RESET line, and PB3 for the CLOCK line.

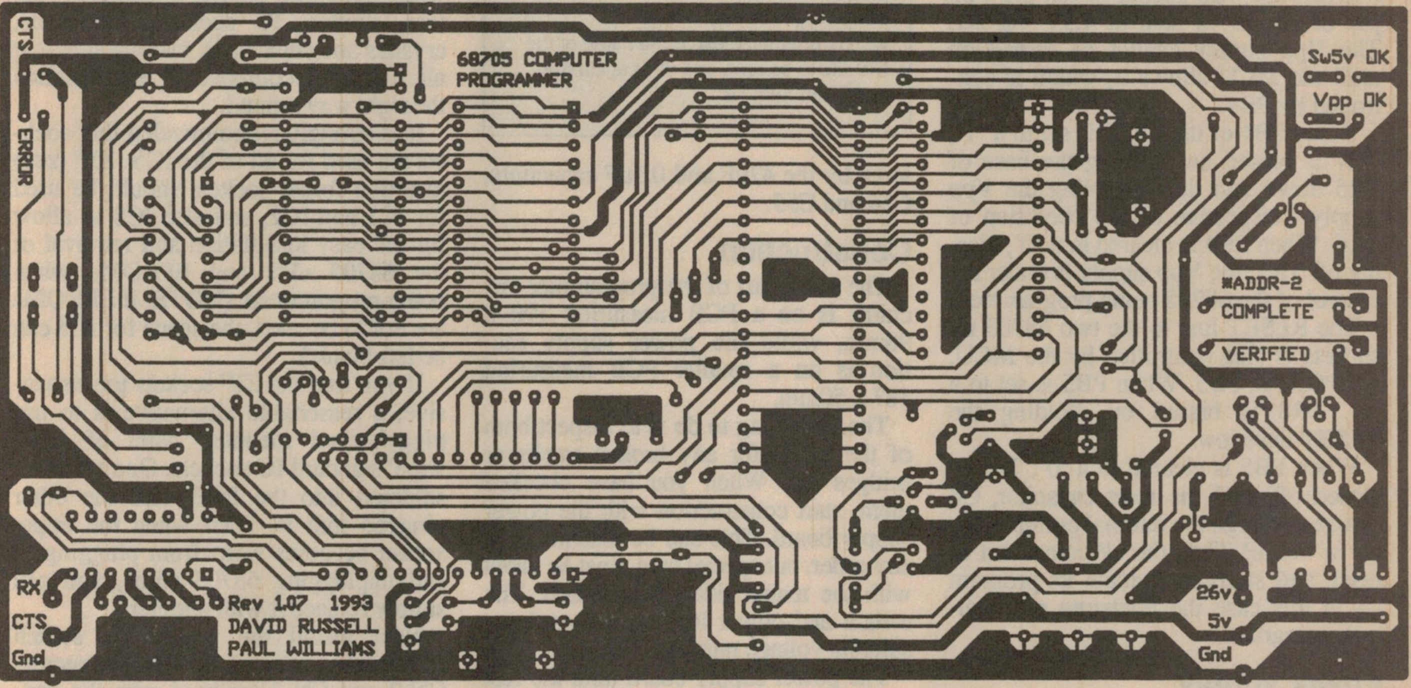
The output enable (OE) pins for both IC3 (static RAM) and IC4 (EPROM) are controlled by the MCU's PORTC, PC0 (pin 8), and PORTB, PB3 (pin 15). The output enable control (PC0) is cleared to a logic '0' for SRAM, and set to a '1' for EPROM programming. Output enable for the SRAM or EPROM will only be turned on when PORTB, PB3 (pin 15 of IC6) goes low, when the MCU goes into programming mode.

The decoding of these two lines is achieved by using IC7 (a 74LS37) to decode/drive the output enable lines, and also LEDs 6 and 7 which indicate which device is being used during programming. The output of PB3 (pin 15 of IC6) is connected to IC7:A, which is used as an inverter.

When PB3 is cleared to a '0', as happens when the programmer goes into program mode, the output of IC7:A will be a '1'. Its output is then connected to both IC7:C, pin 10 and IC7:D, pin 12.



As usual, here are the etching patterns for the two boards used in the programmer, reproduced here actual size for those who wish to etch their own.



This in effect enables either one of these gates to switch on (controlling the output enable of either the SRAM of EPROM), depending on the state of their other input pin.

If PC0 is set to a '1', IC7:D turns on and its output is a '0' — enabling the EPROM, and turning on LED6. If PC0 is cleared to a '0', then it is inverted through IC7:B, and this time IC7:C turns on and *its* output will be a '0' — enabling the SRAM, and turning on LED7. Thus, depending on the state of PC0 when PB3 goes low '0', either IC7:C (SRAM selection) or IC7:D (EPROM selection) will become active.

IC8 is used as the interface chip between RS-232C and TTL levels. The MAX232 chip has its own DC to DC converter, which allows it to generate the +/-10 volts required for RS-232C transmission from a single +5V supply. The serial data transfer coming from the PC comes in on pin 9 at RS-232C levels and is output on pin 8 in TTL levels, which then goes to PB0 of IC6 (pin 12).

Each time a character is received from the PC the MCU sets PB2 (pin 14), the CTS line to a '1', halting the transfer of data from the PC. This ensures that no data is missed while the MCU is processing the currently received character.

When the MCU is ready, it clears the CTS line, restarting the serial data transfer. The CTS line goes to pin 10 of IC8 (MAX232), is converted to RS-232C levels and is output on pin 7, which goes back to the PC.

LED8 is also connected to PB2 via R28. This LED is called the CTS LED and shows the status of the CTS line, with ON meaning ready to receive. The LED will flash while data is being sent from the PC to the programmer.

The STATUS LED (LED3) is driven indirectly by address line 2. When this address line is low, TR1 is turned on by the base current flowing through R3, creating a current path through LED3 and R4, and lighting the LED.

The power supply rails to the 68705 uP being programming and EPROM socket are switched on and off under the control of PORTB, PB3 of the MCU. This line is usually set to a '1', keeping both the SW 5V and SW 26V rails turned off.

To turn these supply rails on, the MCU clears PB3 to a '0'. The current flowing through R5 saturates TR2, turning on the switched 5 volt rail (SW 5V). Current now flows through R7, biasing on TR3, which in turn pulls down the voltage on the base of TR4, biasing it on, and turning on the switched 26 volt rail (SW 26V).

Zener diode D2 is used to regulate a 12 volt rail, through R13, which is fed to the timer pin of the 68705 uP being programmed. This 12V on the timer pin initiates the bootstrap program in the

68705 uP, to program itself when it comes out of reset.

The 68705 being programmed turns on the Vpp supply to itself by clearing its PORTB, PB0 pin to a '0'. This biases off TR6 (which is usually biased on by R19), through D6. As a result the base voltage of TR5 comes up to the zener-regulated 22 volts, from the combination of R15 and D5. TR5 is now biased on, and the SW 26V supply via R14 is regulated to approximately 21.5 volts at its emitter, and supplied to the Vpp pin of the uP.

While the Vpp supply is off, the Vpp pin of the uP is held at 4.5V via D1. The Vpp supply cannot be turned on until the MCU allows it, which is controlled by PB4.

When PB4 of the MCU is set to a '1', TR7 is biased on, holding the base of TR5 down and thus disabling the Vpp supply irrespective of the condition of TR6. When PB4 is cleared to a '0', biasing off TR7, the Vpp supply is under the control of the 68705 being programmed.

The RESET line to the two 68705 uP sockets is also controlled by the MCU, via PORTB, PB5. When PB5 is set to a '1', TR8 is biased on, holding the RESET lines low.

When PB5 is cleared to a '0', TR8 is biased off, and the reset capacitor, C8 charges through the internal pullup resistor in the uP. Then the uP comes out of reset, and starts to execute its program — in this case the bootstrap programming program.

Power supply

The power supply uses a 15 volt centre-tapped PCB mounting transformer, labelled TRAN1. One side of the centre-tapped winding of the transformer goes to full wave bridge rectifier BR1, the output of which is filtered by the 1000uF and 0.1uF capacitors C50 and C59, and then fed to the input of REG2 (LM7805). The regulator output of +5V is filtered by the 0.1uF and 47uF capacitors, C58 and C57.

The other side of the 15 volt winding of TRAN1 is fed through a voltage-doubler circuit comprising C51, D50, D51 and C52, which is 'piggybacked' on top of the first unregulated supply rail. The output of the voltage doubler circuit is then fed to the input of REG1 (LM317) and 0.1uF capacitor C53.

REG1 is an adjustable regulator, with its output set to approximately +26V by the divider network of R50 and R51 on its adjust pin (pin 1), with a 1uF stabilising capacitor C56. Its output is then filtered by the 47uF and 0.1uF capacitors, C54 and C55.

IBM COM PORT SETUP AND OPERATION

To initialise the COM port on an IBM system use:

MODE COMx: 96,N,8,1

for 9600 baud operation, or

MODE COMx: 19,N,8,1

for 19,200 baud operation, where 'x' is a 1 or a 2, etc, to suit the serial port you're using. Note that 19,200 baud is not accessible on all IBM clone PCs via the MODE command.

To send the assembled S19 file to the programmer, type:

TYPE progname.ext > comX:

where 'progname.ext' is the name of the S19 file to be sent, and 'X' is again the serial port number.

Construction

The main part of the programmer circuitry is on a PCB measuring 190 x 98mm, while the power supply section is on a smaller PCB measuring 187 x 50mm.

The first thing to do is to inspect both of the PCBs for any broken tracks or bridges etc. When you have checked them, start construction with the power supply board. This can be assembled in any order, but special care must be taken with the mains side of the board. The switch and power lead used must have suitable voltage ratings.

The power supply board (and the rest of the programmer if desired) must be enclosed in a suitable box, and well insulated. Note that if a metal box is used, the case of the box should be earthed.

The heatsinks on the regulators do not need to be insulated, as long as they don't touch anything else — e.g., the case, each other, or the main programmer board.

When the supply board is finished, bolt it to the bottom of the case using standoff pillars, and check that all of the mains wiring is safe. The power switch can be mounted either directly on the PCB or on the side of the box, depending the style of case used. Once again, make sure that all is well insulated, and safe. Test the power supply when finished (before plugging into programmer board), for the correct output voltages.

Assembly of the main 68705 programmer board is fairly straightforward. Start with the links, then the resistors, diodes, IC sockets, transistors, crystals and capacitors, making sure that all polarised components are installed the right way around.

It is strongly recommended that sockets are used for all of the IC's. ZIF (zero insertion force) sockets should be used for IC1 and IC2, and also IC3 to allow for the easy installation and removal of the 68705 uP's and EPROMs when being programmed. (NOTE: if EPROMs are not to be used, the space for IC3 can be left blank.)

If you find the ZIF sockets too expensive, a reasonable alternative is to use piggybacked identical pairs of 'dual wipe' standard IC sockets. One socket is soldered into the PCB, and the other plugged into it. Then when the upper socket becomes worn from plugging in and unplugging 68705 chips, you can simply replace it with another.

Next install the pushbutton switch SW2, the power and serial connectors CN-2 and CN-3 (or hard wire the connections if you prefer) and the LEDs. Then insert ICs 4 to 8 into their sockets, checking that they are all the right way around.

Now connect the output of the power supply, CN1, to the input of the programmer board, CN2.

Finally make up the lead to connect from the PC's serial port to CN3.

The programmer board can either be left 'naked' or mounted in a box with the power supply — as long as the IC sockets 1 to 3 can be accessed easily. If the programmer is not being placed in a box, square stick-on rubber feet can be used to stabilise the board during use (three large, or 6-7 small feet required).

If the large rubber feet are being used, first cut each rubber foot in half, then place one half-foot over each of the PCB box mounting screw holes which are located near each corner of the board. The two remaining half-feet go near the outer edges of the board in line with IC2.

IBM-COMPATIBLE 68705 ASSEMBLERS

There are at least two public domain 6805 cross-assemblers available to run on IBM-compatible MS-DOS computers. One is TASM (Version 2.88), the other is PSEUDOSAM 68 (Vers. 1.3). The authors say the latter is easier to use, but has a known bug, at least in its earlier versions.

Paul Williams, one of the authors of this article, has written his own 6805 cross-assembler, and is supplying this to *EA* readers on a 5.25" floppy disk along with the pre-programmed 68705P3 controller chip for the programmer (see note in Parts List).

These feet support the board when inserting or removing 68705 processors.

If the small rubber feet are being used, place them in the same locations described for the large feet but then place one additional foot under the middle of IC2 (the 68705R3 socket).

Using it

Before powering up, check all of your work carefully, and make sure that all mains wiring is safe. When you have checked it all, plug the power lead into a power point, turn the unit on and watch for any green smoke...

If none emanates, you are off to a good start. LEDs 2 and 7 should flash three times while the MCU runs through its health checks, and then the CTS LED should come on.

NOTE: if the ERROR LED starts flashing at this point, it could be because the serial cable is not plugged into the PC. Unplug it from the programmer board if possible for these initial tests; if the cable is soldered onto the programmer, plug it into the PC.

When the CTS LED comes on, press SW2 and hold it until LEDs 2 (VPP OK) and 6 (EPROM select) come on. This should take approximately one second, and indicates that the switched supply rails have been turned on by the MCU.

After a few seconds, LEDs 2 and 6 will go out again, and LED 9 (the ERROR LED) will come on. This happens because the MCU has detected that there is no 68705 uP present in either the IC1 or IC2 socket.

If your programmer passes these tests, then it is ready to place an erased 68705 uP into its corresponding socket, and depress SW2 until LEDs 2 and 6 turn on yet again. Then LED3 the STATUS LED should start flashing. At this point the 68705 uP will be programming itself from the EPROM, (in this case an empty socket). After 3.5 minutes the PROGRAM COMPLETE LED and the VERIFIED LED should come on.

Now you are ready for the final test. Plug the lead from the serial port of the PC into CN3, and send the following Motorola S19 line:

SC030000FC

If no errors occur, your new 68705 programmer is ready to use! Happy programming. ❖

PARTS LIST

Resistors

All 1/4 watt:

1 100 ohms (R14)
1 120 ohms (R50)
1 220 ohms (R4)
3 390 ohms (R23,24,29)
5 470 ohms (R1,11,12,22,28)
3 1k (R5,16,20)
2 2.2k (R2,51)
2 4.7k (R13,15)
14 10k (R3,6,7,8,9,10,17,18,19,21,25,26,27)

Capacitors

2 75pF ceramic (C5,13)
2 100pF ceramic (C4,12)
5 0.1uF monolithic (C1,6,9,11,14)
4 0.1uF met. polyester (C53,54,58,59)
1 1uF tantalum 16VW (C8)
8 10uF tantalum 16VW (C7,15,16,17,18,19,20,57)
2 10uF tantalum 35VW (C2,3)
1 1uF electrolytic 35VW (C56)
1 47uF electrolytic 10VW (C57)
1 47uF electrolytic 35VW (C55)
1 220uF electrolytic 25VW (C51)
1 470uF electrolytic 63VW (C52)
1 1000uF electrolytic 16VW (C50)

Semiconductors

1 V02 bridge rectifier (BR1)
5 1N4001 diode (D1,3,4,50,51)
1 BZX79C12 12V zener diode (D2)
1 BZX79C22 22V zener diode (D5)
2 1N4148 signal diode (D6,7)
4 Green LEDs (LED1,2,5,8)
2 Red LEDs (LED4,9)
3 Yellow LEDs (LED3,6,7)
1 BC337 NPN small signal (TR5)
4 BC547 NPN small signal (TR3,6,7,8)
1 BC558 PNP small signal (TR1)
2 BC640 PNP power/audio (TR2,4)
1 LM317 adj. regulator (REG1)
1 LM78L05 5V regulator (REG2)
1 4040 CMOS counter (IC5)
1 68705P3 microcomputer* (IC6)
1 6264 (SRAM) 8K x 8-bit (IC4)
1 74LS37 TTL quad gate (IC7)
1 MAX232 serial interface (IC8)

Miscellaneous

1 Main PC board, 190 x 98mm
1 Power supply PCB, 187 x 50mm
2 TO-220 heatsink brackets (for REG1,2)
1 15V CT power transformer, 7VA PCB mount (Arlec type 74 7 15, Jaycar MF-1004, or Altronics M-7115)
3 3-pin 0.2" spacing connectors (CN1,2,3)
2 28-pin IC socket (for IC4,6)
1 24-pin ZIF socket (for IC3 — optional)
1 28-pin ZIF socket (for IC1)
1 40-pin ZIF socket (for IC2)
1 1MHz crystal (XTAL1)
1 4MHz crystal (XTAL2)
1 M205 500mA fuse (F1)
2 M205 fuse clips, PCB mount
1 DPDT switch, 240V AC 2A (SW1)
1 SPDT switch, 0.2" PCB mount (SW2)

*Author Paul Williams can supply 68705P3 devices already programmed with the firmware required for the operation of this project, along with a free copy of his 6805 cross-assembler on a 5.25" floppy disk.

The pre-programmed devices are currently priced at $49.95, including postage within Australia, and are available from:
Microchip Solutions
13 Cumming Street,
Wodonga, Vic 3690.

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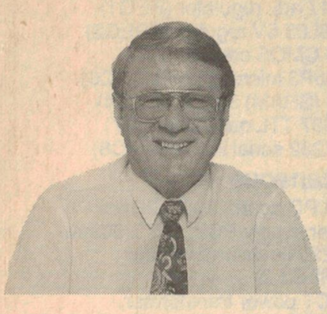

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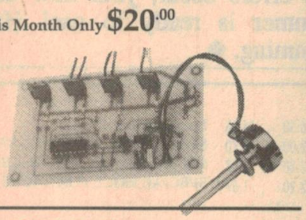

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Gate Source Voltage: ±14V
Drain Current: 16A
Body Drain Diode: 16A
Total Body Dissipation: 250W

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Z 1454	2SK176	$19.50
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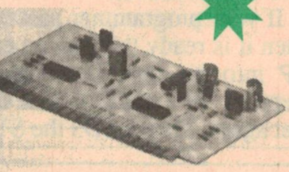

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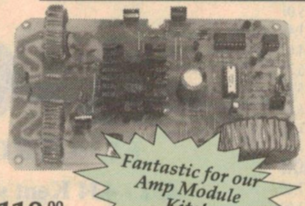

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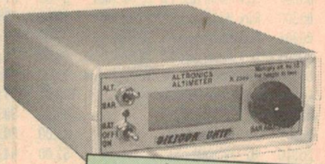

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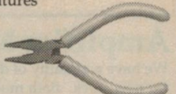

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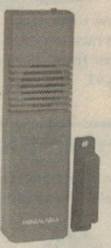

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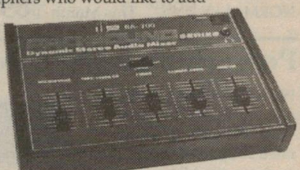

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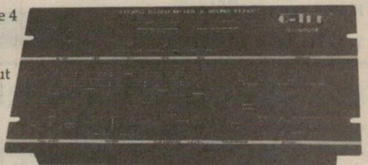

Features: • 5 channels with 8 inputs (first 3 channels are switchable between 2 inputs • Input facilities include: DJ mic, mic, phono 1, phono 2, line 1, line 2, line 3, line 4 • All inputs other than microphones are stereo • Treble, bass and master volume controls allows you to fine tune the output • Cross fader control between phono 1 and 2 • Cue monitor select and level • Twin LED master VU displays • Special effects circuit simulates, bombing, laser, ambulance, shooting, siren, machine gun, telephone and storm. Ideal for DJ's, bands etc.

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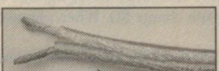

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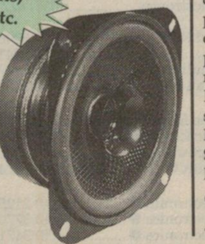

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SHORTWAVE LISTENING

with Arthur Cushen, MBE

Radio for the visually handicapped

In Australia and New Zealand the use of radio to provide a reading service for those many listeners who have a sight impairment is well established. It provides a special means of transmission, bringing into the home daily newspapers, magazines and books for the many thousands who cannot read.

Radio for the Print Handicapped is well established in the capital cities in Australia, and does tremendous work to keep its blind and sight-impaired listeners up to date with news and information. The audience is wide, and not only covers those with a slight problem but also the many who have a reading problem — for example, migrants whose knowledge of print is not as good as their speech, and those who have medical problems such as dyslexia.

At the heart of these organisations are the voluntary readers who give up their time. With an understanding of their audience, they read to them on a very personal basis, and one feels that you are tuned into a reader who is doing the job especially for you. Having visited 3RPH in Melbourne, I am conscious of the tremendous service of volunteers, and the financial support of the community which keeps these stations in operation.

In New Zealand, Radio for the Print Handicapped has been restyled Radio for the Print Disabled, and emphasises that it is operating for anyone who cannot read the printed word. Based in Levin, a recent extension and the introduction of the third transmitter has meant that two shortwave frequencies are operating for the major part of the day. This gives national coverage from the Levin studios, while the shortwave frequencies of ZLXA are nationwide.

Broadcasts commenced from Levin on 9th May 1987, and originally transmissions were on the AM dial on 1602kHz from station 2XA. In 1990 a shortwave frequency was assigned with the call ZLXA using 3935kHz, and later a second channel for daytime reception, 7290kHz was added. Last year, a third transmitter was put into service so that the three frequencies could operate simultaneously; Sunday - Thursday 2100 through to 0900 Monday - Friday, on 2XA 1602, ZLXA 3935 and ZLXA 7290. The frequency of 7290 closes at 0500, while the transmission on Sunday is 0500 - 0800.

The service was pioneered by Allan Little who started his broadcasting career in Wanganui with a small, private short term broadcaster. Later he moved to Levin to set up what was then Print Disabled Radio. With a band of conscientious volunteers the station soon became known nation-wide. With its two shortwave frequencies it is within the reach of any New Zealander who requires a radio reading service, as either one of the ZLXA channels is audible throughout the daylight hours.

There are several specialised programmes on the station's schedule. On Monday at 0800, CQ Pacific is a combined 30 minute presentation from the New Zealand Radio DS League and the New Zealand Association of Radio Transmitters, in which Arthur Cushen and Jim Meacham present news of the shortwave bands and radio amateur activity.

The address of Radio for the Print Disabled is: PO Box 360, Levin, New Zealand. Verification cards are issued to those reporting reception, provided that return postage (in the form of mint stamps or IRCs) is enclosed.

Sunspots falling

The 11 year cycle in which sunspot activity varies is now in the phase where they are decreasing. However predictions of the low sunspot period are still not defined. Mike Bird, reporting on Radio Nederland, indicated that for the last sunspot cycle the predictions were all wrong!

The cycle is made up of four years of growth and seven years of decline. Though the predictions were that the maximum would take place in 1991, this actually occurred in 1989 — and six of the latest solar cycles were actually less than 11 years in duration.

If the sunspots decline as predicted, by mid 1995 they should be at the minimum and last until late 1996. If the minimum takes place in late 1996, this will be another ten year cycle, whereas if it takes place earlier in 1995, it will mean that there has been a nine year solar cycle...

The falling sunspots have a direct reference to international broadcasting, and the lower sunspot count forces stations to use the lower frequency bands such as the 25, 31, 41 and 49 metre bands.

There will be considerable congestion in these frequency bands as we near the time of the sunspot minimum. This will mean, on the other hand, that there will be little activity in the 11, 13 and even 16 metre bands as international broadcasters move to lower channels. ❖

AROUND THE WORLD

ABU DHABI: Abu Dhabi, in the United Arab Emirates, operates from 2200 - 2400 in English. Sign on is with a Koran reading and then at 2215 there is a feature programme; at 2230 it gives details of frequencies: 9770, 11,710 and 13,605kHz. 11,710kHz is the best frequency. At 2230 the programme joins Capital Radio FM in Abu Dhabi.

ALASKA: The latest schedule of KNLS in Anchor Point Alaska, up to March 26 1994, has English broadcasts at 0800 - 0900 on 7365 and 1300 - 1400 on 7355kHz. The balance of broadcasts are in East Asian languages.

GUAM: AWR KSDA has made a frequency change from 11,980 to 7455kHz, with English at 1600 - 1700. This is typical of the need to move to lower frequencies to keep pace with the falling sunspots.

HUNGARY: Budapest has English to North America at 0200 - 0300 on 5970, 9835, 11,910 and 15,220kHz; and to Europe at 2100 - 2200 on 6110, 7220, 9835 and 11,910kHz.

ITALY: Adventist World Radio, Forli has English from 0700 - 0800 on 7210kHz and from 1000 - 1100 on 7230kHz. AWR Samara has English from 0530 - 0600 and 1700 - 1730 on 12,060kHz.

NORWAY: Oslo broadcasts in English to this area on Sunday , at 0800 on 15,175 and 17,740kHz; at 1000 on 17,840 and 21,705kHz; and at 1200 on 21,705 and 25,730kHz. During February, and the Winter Olympics, Radio Norway will add a five minute programme in English daily at the same schedule times, and on frequencies that carry English on Sunday. This should be heard around 25 minutes past the hour.

SINGAPORE: The Singapore Broadcasting Corporation is to expand its shortwave services. It will carry four languages and will use one 100kW and six 250kW transmitters. The transmitters will be located next to the BBC relay base, but will be an independent operation.

The frequencies are SBC Radio 1 in English on 6155 and 9530kHz; the City Sound Service in Mandarin on 6000 and 9635kHz; and the Malay Service on 7250 and 9590kHz. All these frequencies will be using 250kW, while 7170kHz will carry the broadcasts from Singpore in Tamil using 100kW. These are relays of the Domestic Service, and the Engineering Department Chief stresses that this is in order to improve reception in the surrounding countries, since the signals are not beamed to any particular area of the world.

SPAIN: Radio Exterior De Espana, Madrid is on the new frequency of 9540kHz with English from 000 - 0200 and 0500 - 0600 to North America. This new frequency of 9540 replaces 9530. On Sunday at 0510 a DX programme is broadcast.

SWITZERLAND: SRI Berne has changed two frequencies for its service to Australia and has English from 0900 - 0930. The frequencies are 9885, 13,685 and 21,820kHz — both 9885 and 21,820kHz are new frequencies carrying this service.

TAIWAN: The voice of Free China using the transmitter of WYFR Okeechobee Florida, with a programme in English from 2200 - 2300, uses 11,915kHz. The studios of the Voice of Free China are in Taipeh, Taiwan and the station has leased time from WYFR to carry this service to Europe.

YEMEN: Broadcasts from Sana'a in English have appeared at 2115 on 9780kHz. The transmission includes a new bulletin in English with short breaks of Arabic music at 2140 identification is given, and then follows a programme of reading from the Koran. ❖

This item is contributed by Arthur Cushen, 212 Earn Street, Invercargill New Zealand who would be pleased to supply additional information on medium and shortwave listening. All times are quoted in UTC (GMT) which is 11 hours behind Australian Eastern Daylight Time and 13 hours behind NZ Daylight Time.

Mini Construction Project:

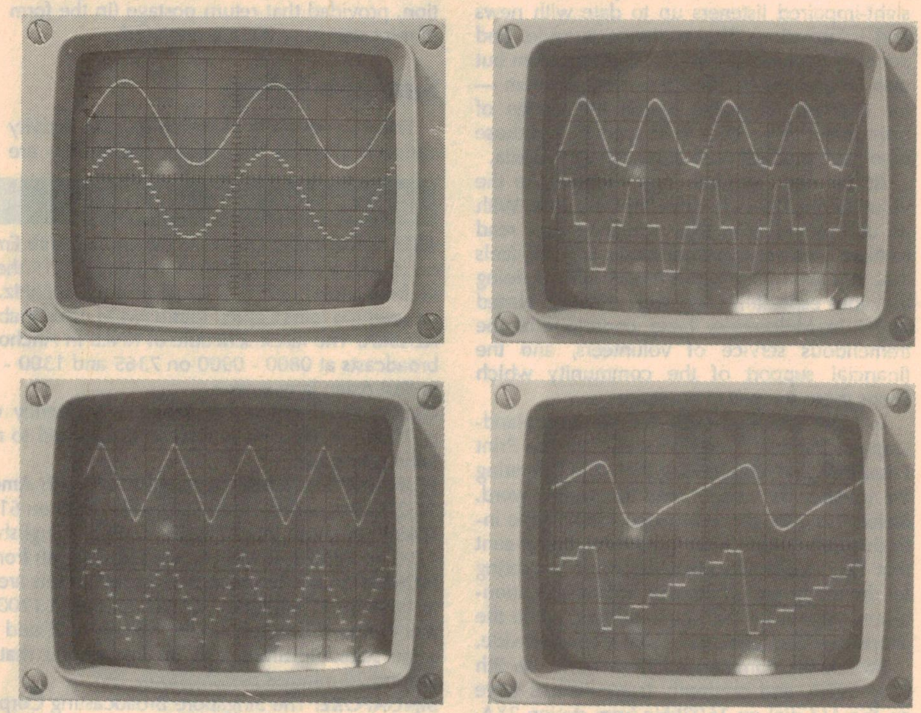
DIRECT DIGITAL SYNTHESIS ON A PC

Following our articles on direct digital synthesis (DDS) chips and their use, in the March issue, the author of this article contacted us to explain that he had worked out a simple method of making a PC perform DDS — using software. Did we think other readers would be interested? We certainly did, so at our invitation he provided the following description of this innovative technique...

by RICK MATTHEWS

Unlike systems which make use of the new and relatively expensive DDS chips, the DDS technique described here is cheap and easy to generate on a standard PC. It generates precision frequencies in the audio range (from 1Hz to about 12kHz), and its output can be either sine, square, sawtooth, triangle, or virtually any repetitive waveform. The output is easily displayed on a low bandwidth CRO (say 5MHz), and it is ideal for experimenting with or demonstrating the principles of DDS.

The maximum frequency is limited by the speed of the PC, and the choice of a reasonable reference frequency. In my case a 25MHz 386SX PC with 16K cache operates satisfactorily with a reference clock frequency of 32,768Hz. The reference oscillator also gives a convenient binary number of 32,768 values for the lookup table, and if you take 40% of the reference as the practical upper frequency limit, you get 13kHz — which gives a reasonable coverage of the audio range.



Four samples of the waveforms which can be produced from the author's software DDS, in each case with the filtered output at the top. Uppermost are sinewaves at 1024 and 8192Hz, with a 2048Hz triangle and 4096Hz sawtooth below.

The hardware required is relatively simple and is connected to the PC's printer port.

The software uses printer port LPT2:, simply because LPT1: usually has a printer connected to it. Because most PC's have IDE hard disc controllers with only one printer port, you may need an extra printer card if you want to leave your printer undisturbed. But if LPT1: is unused and you want to use it for this application, then the addressing is

data	=	378H,
status	=	379H, and
control	=	37AH

The IDE or extra card must be strapped for these addresses and their addresses must not clash.

The reference clock uses a 32,768Hz crystal, which can either be bought new for about $3, or extracted from an old PC motherboard or digital watch. The output of the oscillator is connected to pin 11 (printer BUSY line) of the printer port. The software tests the oscillator output for the transition from low to high, to synchronise to the generator.

The 8-bit wide output from the printer port drives an octal 74HCT541 CMOS buffer. The 'T' in the designation indicates the buffer can be directly driven by the TTL printer port output, without the need for pullup resistors or some level shifter on the CMOS chip's inputs. The CMOS buffer provides a full 0 to 5 volts output to drive the R/2R resistor network digital-to-analog converter. A CMOS buffer is chosen because the unbuffered TTL printer port or a TTL buffer will not satisfactorily drive this type of D/A ladder network.

In this application the R/2R ladder network is fairly tolerant to resistor value variation, which tends to be absorbed as a characteristic of the network. In fact, values of 3.3k for R and 6.8k for 2R are acceptable, although two 3.3k resistors in series for 2R are better. Standard 10% resistors are good enough for all resistors.

The high impedance D/A network is

Alternative hardware

Readers who built our PC-Driven Function Generator (described in the January 1989 issue) could very likely adapt its hardware for use with the DDS software developed by Rick Matthews. Although we haven't had the opportunity to try this as yet, we would expect it to quite straightforward.

You'd need to convert gates IC4c and IC4b into the 32.768kHz reference oscillator. The other main modification would be to disconnect pin 12 of IC4a from the printer port STROBE-bar line, and tie it to ground so that the octal buffer chip IC1 is permanently held in its 'transparent' mode.

The simple low-pass filter in the earlier design will probably be OK for many purposes, but for more demanding use the existing output buffer stage around IC3b could easily be converted into an active LP filter using the same component values given by Mr Matthews.

```
#include <stdio.h>
#include <math.h>
#include <conio.h>

#define pi 3.141593

unsigned char table[32768];
double a, b;
unsigned n;
FILE *fp1;

main(int argc, char *argv[])
{ if((fp1 = fopen("SINE","wb")) == NULL)
          { printf("\nCannot open output file\n");
                  exit(1);
          }

          /* set up a table of 32768 8-bit values */
          a=0;
          b=pi/16384;
          for(n=0; n<32768; n++)
          { a+=b;
                  table[n]=128*sin(a)+128;
          }

          fwrite(table,1,32767,fp1);
          fwrite(table+32767,1,1,fp1); /* write very last byte */
          fclose(fp1);
```

This listing shows the source code (in C) for the small program which generates the sinewave lookup table for the main DDS program. The author supplied a number of other waveform generating programs, which are available to readers.

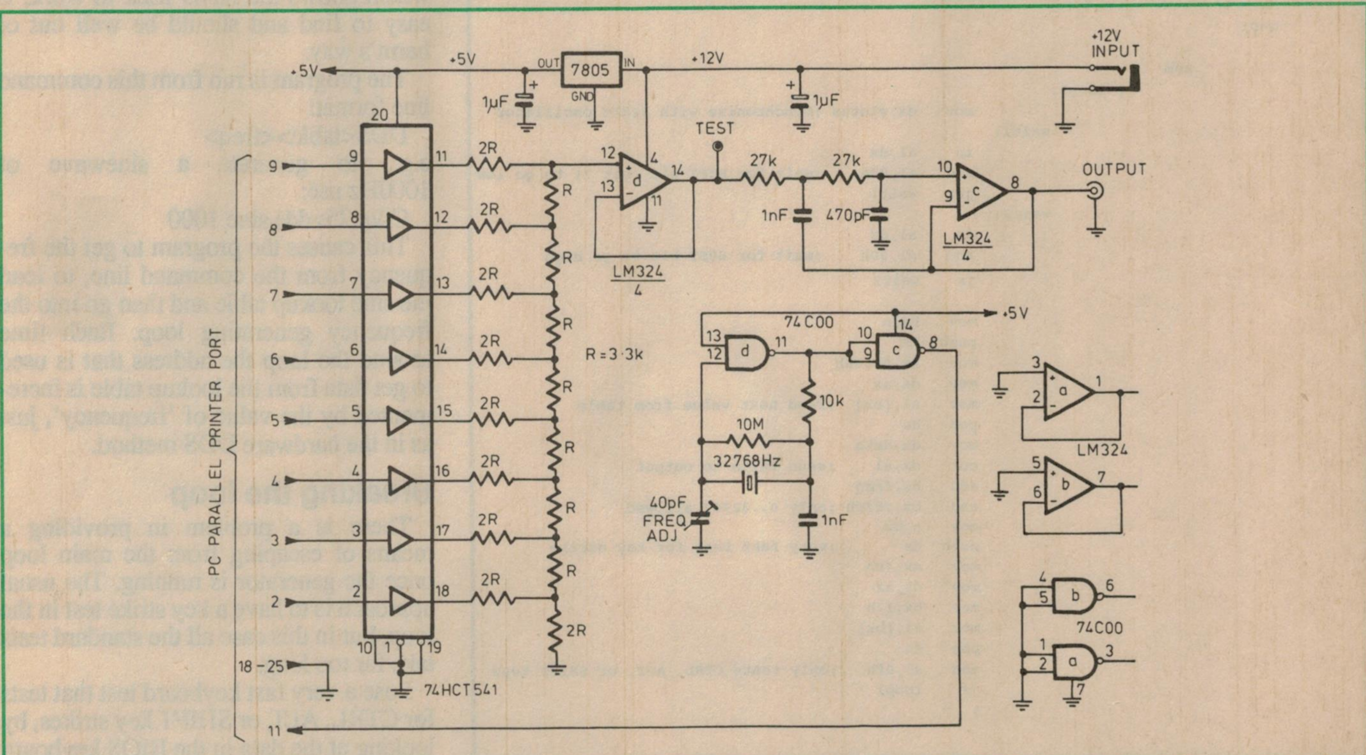
buffered by an op-amp, which in turn is followed by a low pass filter with a cutoff of about 10kHz. Both of the op-amps are powered from the 12V rail.

The D/A ladder network has an output that ranges from 0 to 5 volts and most op-amps, including the LM324, will not operate linearly if the input gets within about 1.5 to 2V of the supply — so that at least 6.5 to 7V are required. 12V was used because it is a readily-available standard and is still well within the safe operating limits of the LM324.

There are two signal outputs indicated on the circuit. If you want to see best the effects of aliasing, staircase effects, phase jitter, etc., on a CRO, then you look at the buffer amp's output.

But if you want a cleaner waveform, perhaps for some application other than viewing on a CRO, then use the filter's output.

The software uses a mixture of C and assembly language — C for simplicity, where speed is no problem, and as-



As the author's software routines perform all of the 'hard work' for direct digital synthesis, the hardware required is very simple indeed. A 74HCT541 octal buffer is used to drive a 'binary ladder' of resistors, to form a very low cost digital to analog converter which is followed by a simple buffer and lowpass filter. The crystal oscillator provides reference pulses.

```
#include <stdio.h>
#include <conio.h>
#include <dos.h>

/* lpt2: parallel printer port */
#define data 0x278
#define status 0x279
#define control 0x27a

unsigned char table[32768];
unsigned n, freq;
FILE *fp1;
struct SREGS segregs;

main(argc,argv)
int argc;
char *argv[];
{ if(argc!=3)
        { printf("\nUsage is:- FREQGEN table frequency\n");
                exit(1);
        }
        if((fp1 = fopen(argv[1],"r+b")) == NULL)
        { printf("\nCan't open table file . . .\n");
                exit(1);
        }

        /* get frequency from command line */
        freq=atoi(argv[2]);
        if(freq>16768)
        { printf("\nFrequency too high (must be 0..16768)\n");
                exit(2);
        }

        /* read in table of 8 bit values */
        fread(table,1,32767,fp1);
        fread(table+32767,1,1,fp1); /* read very last byte */

        /* move the data to a more easily accessible location */
        segread(&segregs);
        movedata(segregs.ds,&table,0x8000,0,0x8000);

        printf("Generator running (hit CTRL, ALT, or SHIFT to exit). . .\n");

        n=0;

                _asm
                        { loop1:
                                        mov     dx,status ;synchronize with 32kHz oscillator
                        wait1:
                                        in      al,dx
                                        and     al,80h    ;wait for BUSY bit (bit 7) to go low
                                        jnz     wait1
                        wait2:
                                        in      al,dx
                                        and     al,80h    ;wait for BUSY bit to go high
                                        jz      wait2

                                        mov     bx,n
                                        push    ds
                                        mov     ax,08000h
                                        mov     ds,ax
                                        mov     al,[bx]   ;read next value from table
                                        pop     ds
                                        mov     dx,data
                                        out     dx,al     ;send value to output
                                        add     bx,freq
                                        and     bx,7fffh  ;only 0..32767 allowed
                                        mov     n,bx
                                        push    ds        ;very fast test for key strike
                                        mov     ax,40h
                                        mov     ds,ax
                                        mov     bx,17h
                                        mov     al,[bx]
                                        pop     ds
                                        and     al,0fh    ;only tests CTRL, ALT, or SHIFT keys
                                        jz      loop1
                                        }
```

Here is the main source code listing for the author's DDS program itself. Most of the program is written in C, as you can see (sorry for the pun!), with the actual waveform generation section in assembly language (lower section).

sembler where high speed is essential. The programs were compiled with Microsoft's Quick C. Any other C compiler that can include assembly language code should be OK, allowing for dialect.

The waveform tables are generated separately and saved to disc as files. They are loaded each time the main program is run. This avoids the long time it takes, especially for sinewave tables, if they are generated each time the DDS program is run.

The program listings are fairly straightforward, except perhaps when reading or writing to disc. We have 32,768 bytes to read or write.

The limit for Microsoft C for one block is 32,767, or just one short of the number we need. The easy solution is to read or write the 32,767 bytes allowed and then read or write the last byte as an additional instruction.

To make it quick and easy to keep the lookup table addresses confined to the range 0 to 32,767, but with wrap around, the addresses are ANDed with 7FFF hexadecimal each time around the loop after the frequency increment is added.

Because the segment and offset of the lookup table are chosen by the compiler, and because it cannot be assumed the compiler will choose an offset range of 0 to 32,767, the program shifts the lookup table to segment 8000H with offset 0 — which allows the AND trick to work, is easy to find and should be well out of harm's way.

The program is run from this command line format:

DDS<table><freq>

e.g., to generate a sinewave of 1000Hz use:

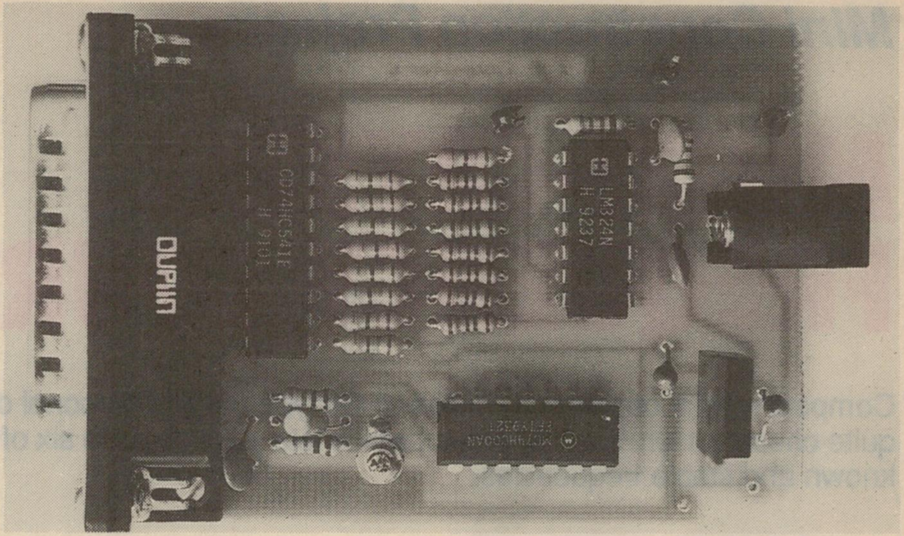
C:\qc25>dds sine 1000

This causes the program to get the frequency from the command line, to load the sine lookup table and then go into the frequency generating loop. Each time around the loop the address that is used to get data from the lookup table is incremented by the value of 'frequency', just as in the hardware DDS method.

Breaking the loop

There is a problem in providing a means of escaping from the main loop once the generator is running. The usual approach is to have a key strike test in the loop, but in this case all the standard tests take far too long.

I use a very fast keyboard test that tests for CTRL, ALT, or SHIFT key strikes, by looking at the data in the BIOS keyboard buffers at the bottom of memory. Another way is to connect a momentary switch to an input pin on the printer port and test it each time around the loop.



If you are planning to build up Eric Patching's PCB version of the hardware side of this DDS, here is a photo showing the location of the parts. A small DC connector has been added in this case, at centre right.

Phase jitter is a significant problem for DDS, and it is more of a problem as the chosen output frequency becomes a greater proportion of the reference. Phase jitter shows up on a CRO as horizontal jitter of the waveforms, by an amount as much as the period of the reference frequency plus the time for the software to detect the reference's leading edge.

In a similar way, the DAC staircase effect contributes most to 'digitising noise' which increases as higher frequencies are chosen. This is seen as increasingly larger steps in a 'staircase' as the frequency is increased.

Interrupts from the PC's real-time clock at 18Hz also contribute to phase jitter, but not significantly over and above this method's inherent DDS phase jitter. It will be less noticeable on faster PCs. If interrupts are a problem, and they are disabled, special steps need to be taken to exit from the main loop (because the keyboard is also interrupt driven).

Other waveforms

Apart from sine waves, which are normally the only waveforms associated with DDS systems, with this method you can generate square wave, sawtooth, triangular waveforms, and you need not stop there. Composite waveforms such as part sine and part sawtooth, part sine and part square, full and half wave rectified waveforms, part noise and part sine, or even just plain noise can be readily generated with the appropriate lookup table.

These are all mathematically derived functions (the noise is pseudo-noise), but of course, you can even prepare completely non-mathematically derived waveforms, say a fragment of speech — letting you select the pitch afterwards, if you wish. You can really let yourself go!

The description so far assumes that once the frequency is selected from the command line it stays fixed.

However, there is no reason why you couldn't write software to vary the frequency up or down, to produce a precision glide-tone generator. You could even frequency-modulate or phase-modulate the generator, if you wish. Even though this software-driven DDS generator is confined to the audio range, it is quite versatile and provides plenty of scope for innovation.

Improved hardware

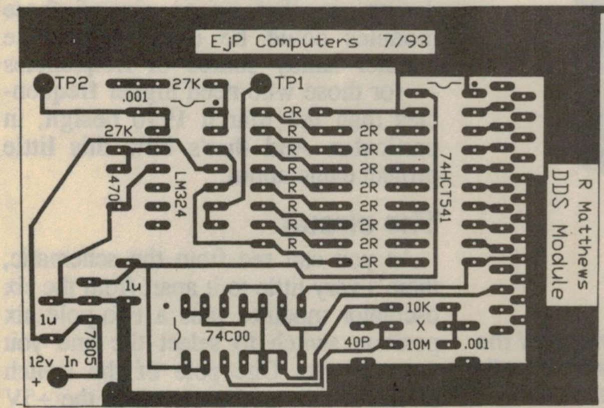
My prototype of the hardware side of the project was wire-wrapped, and connected to the PC printer port via a cable only a metre or so long.

This worked very satisfactorily, but when some of my friends made up similar units and connected them to their PCs via longer cables, they found it necessary to wire the remaining gates of the 74C00 (shown unused on the schematic) in parallel with the existing reference clock buffer driving pin 11 of the printer port.

The three gates in parallel are better able to drive the additional capacitance of a longer cable, preventing distortion of the 32,768Hz reference clock pulses. One friend also wanted to connect a long cable to the 'Test' output, so he could display and compare both the unfiltered and filtered outputs on the CRO. To reduce the filtering effect of cable capacitance on the unfiltered output, he wired one of the two currently unused LM324 amps as an additional buffer, between the output of the first buffer (pin 14) and the Test output socket.

Those who decide to make up a PCB for the project might care to make both of these modifications, to ensure the best possible performance from the same number of low-cost components.

Pictured is a PCB version made up by Eric Patching, which works very well. The pattern for this is presented as well, for those who may wish to copy it.



Here is the PCB pattern for the hardware side of the author's DDS, as designed by his colleague Eric Patching. It's reproduced here actual size for those who wish to etch their own board.

Editor's Note: Due to limited space, we have only been able to reproduce here the source code listings for the author's DDS program and sinewave lookup table. However Mr Matthews has made available to us a disk with files for both these and a variety of other waveform tables — including square, sawtooth, triangle, complex waveforms and pseudo-random noise.

The files include not only the source code for the DDS program itself and the waveform lookup table generation programs, but also the EXE versions of each — and even the actual lookup tables, ready to run with the DDS.EXE file for those without a C compiler. Interested readers can obtain copies of all of these files by sending us a formatted HIGH DENSITY floppy disk (5.25"/1.2MB or 3.5"/1.4MB), plus $5.00 to cover copying and return postage within Australia. ❖

MULTI-CRYSTAL FREQUENCY SOURCE

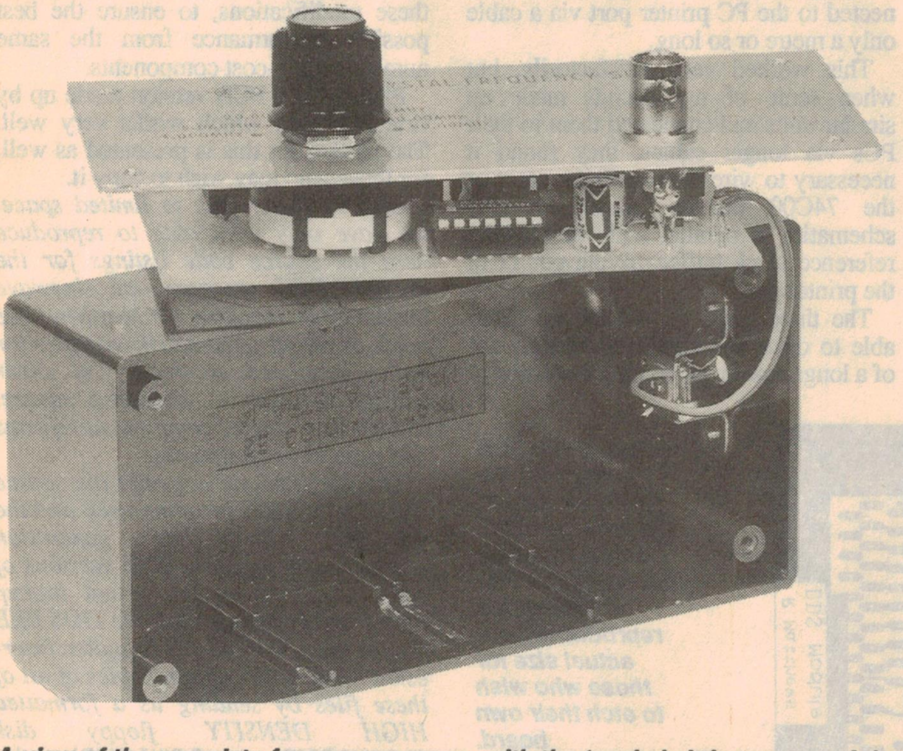
Compact crystal oscillator modules of the type used in personal computer boards are now available quite cheaply. Here's a little project which lets you use up to six of them to provide a handy source of known and stable frequencies.

by JIM ROWE

If you do much experimenting or working with electronics, you'll know that a source of known stable frequencies can be very useful for checking the calibration of counters, scopes, receivers and so on. Such a source can often also be used as a makeshift signal or pulse generator, for testing circuits under development.

Back in the March 1990 issue, I described a simple source of this type using a low-cost 10MHz crystal with a handful of chips to divide its output down to a string of useful frequencies, from 5MHz down to 5kHz. This unit seems to have been fairly popular, and the prototype has certainly been very handy on my own workbench. However the main complaint about this earlier design has been that it doesn't go *high* enough, in terms of frequency.

I had pondered the idea of designing a more elaborate unit with a higher frequency crystal, but there were problems. When you go much higher than 10MHz, many of the commonly available digital IC families start 'falling over'...



A view of the complete frequency source, with the 'works' sitting on top of the case. Note that although buffer chip U1 is shown here in a socket, this isn't really necessary. The PCB mounts directly on the back of the rotary switch.

Just recently, however, I discovered that Oatley Electronics had acquired good stocks of surplus TTL crystal oscillator modules, of the very compact type used as clock pulse generators in many personal computer boards. Housed in a hermetically sealed metal can roughly the same size as a 14-pin DIP IC package, these modules are available from Oatley in a range of frequencies up to 50MHz, and at very low cost: $7 each, or five for $25.

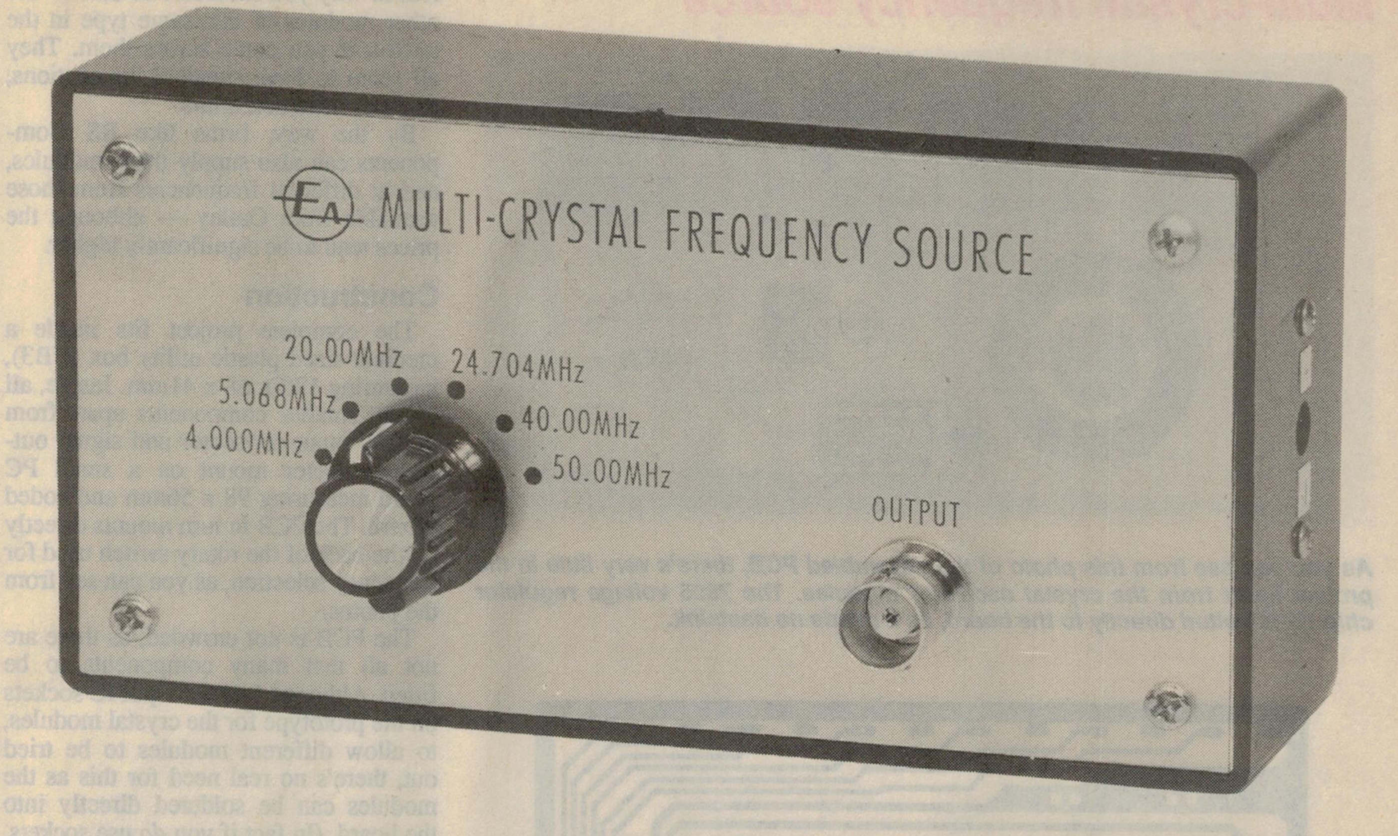
Oatley's ever-helpful Branco Justic sent me some samples of the modules, and I soon discovered how suitable they were for making a higher-frequency signal source.

They have only four pins, one of which has no internal connection; all you have to do is apply +5V to one of the remaining three, ground another and the module produces its output from the last. The output is essentially a square wave, switching between standard TTL levels with an amplitude of about 2V p-p, and at the frequency marked on the module (within about 100 parts per million).

Needless to say it didn't take very long at all to produce a small PCB design, so that up to six of these modules could be used to produce another handy source of frequencies — for those who need higher frequencies than the March 1990 design, in particular. And that's how this little project came about.

The circuit

As you can see from the schematic, there's very little to it apart from the six oscillator modules plus a two-pole six position switch to select the one you want to use. One pole of the switch selects which module receives the +5V



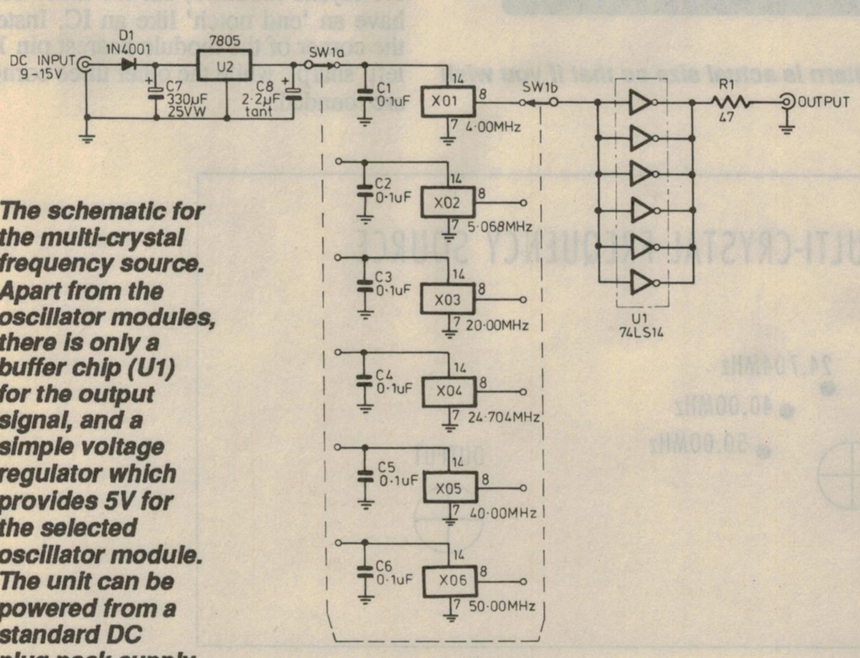
supply, while the other connects that module's output to a simple but effective output buffer (U1) formed by connecting all six inverters of a 74LS14 hex Schmitt inverter in parallel.

Resistor R1 gives the buffer an output impedance of around 50 ohms, and also protects the chip from damage in the event of an accidental short circuit on the output cable.

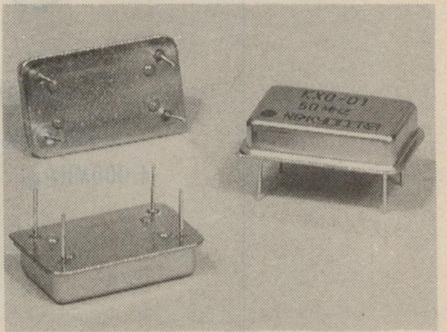
Rather than give the circuit its own expensive power supply, like the 1990 project it is designed to make use of a standard 'plug pack' DC supply delivering between 9V and 15V. A low-cost three terminal 5V regulator (U2) is used to reduce this down to a stable +5V, with capacitor C7 used to ensure that there is adequate ripple filtering and C8 to keep the regulator stable. Capacitors C1-C6 are used to provide good supply bypassing for the oscillator modules themselves, while diode D1 is used to protect the circuit from accidental connection to a plug pack with reversed polarity.

Note that the output buffer chip U1 also has a 0.1uF supply bypass capacitor (C9), although this is not actually shown on the schematic.

That's all there is to it. The modules currently available from Oatley Electronics have frequencies of 50MHz, 40MHz, 24.704MHz, 20MHz, 5.068MHz and 4MHz — most of which are quite handy. However there's no

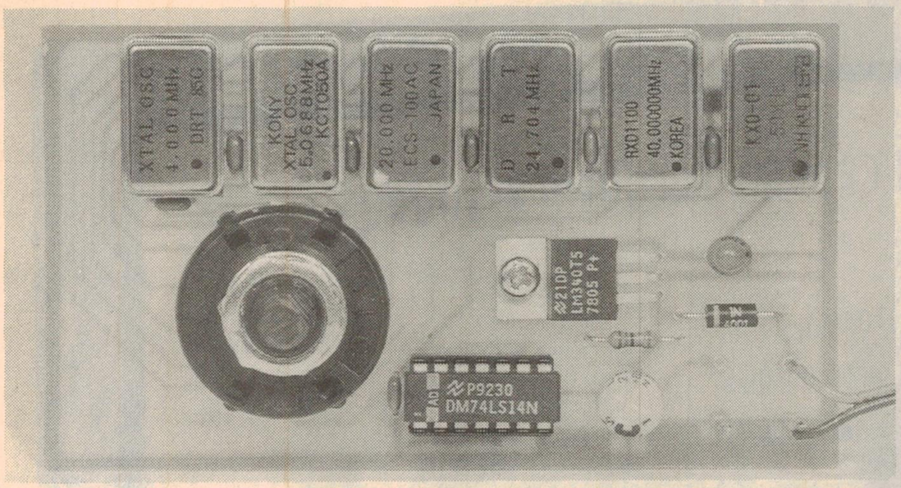


The schematic for the multi-crystal frequency source. Apart from the oscillator modules, there is only a buffer chip (U1) for the output signal, and a simple voltage regulator which provides 5V for the selected oscillator module. The unit can be powered from a standard DC plug pack supply.

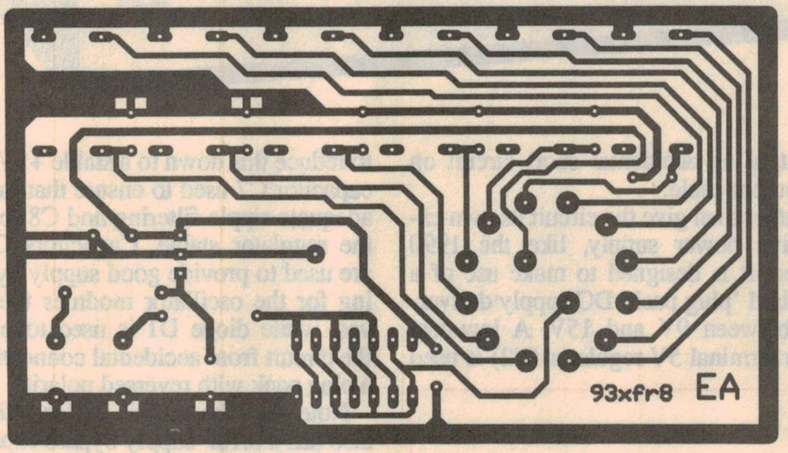


Samples of the crystal oscillator modules used in this project. They're the same size as a 14-pin DIL IC.

Multi-crystal frequency source



As you can see from this photo of the assembled PCB, there's very little in the project apart from the crystal oscillator modules. The 7805 voltage regulator chip U2 is bolted directly to the board, as it needs no heatsink.



As usual, this reproduction of the PCB pattern is actual size so that if you wish you can etch your own board from it.

reason why you shouldn't be able to use other modules of this same type in the circuit, if you come across them. They all seem to have standard connections, as far as I can determine.

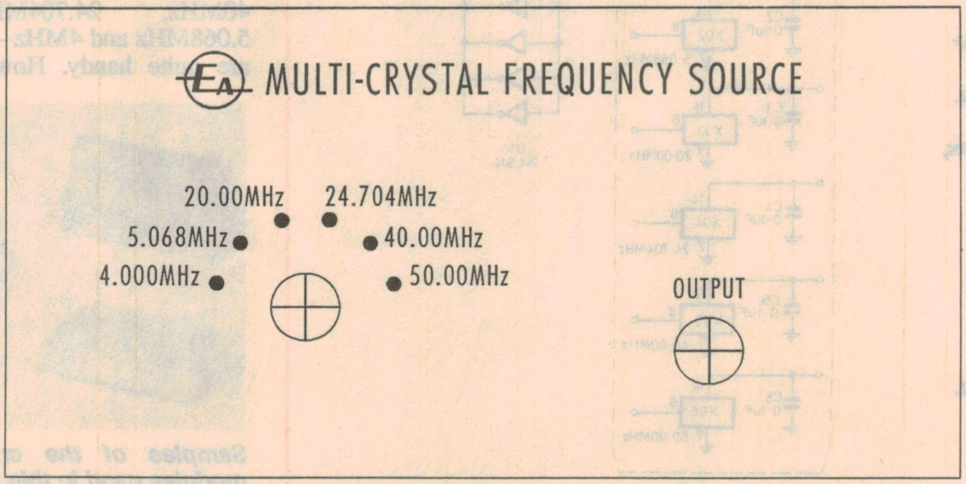
By the way, firms like RS Components can also supply these modules, and at different frequencies from those available from Oatley — although the prices tend to be significantly higher.

Construction

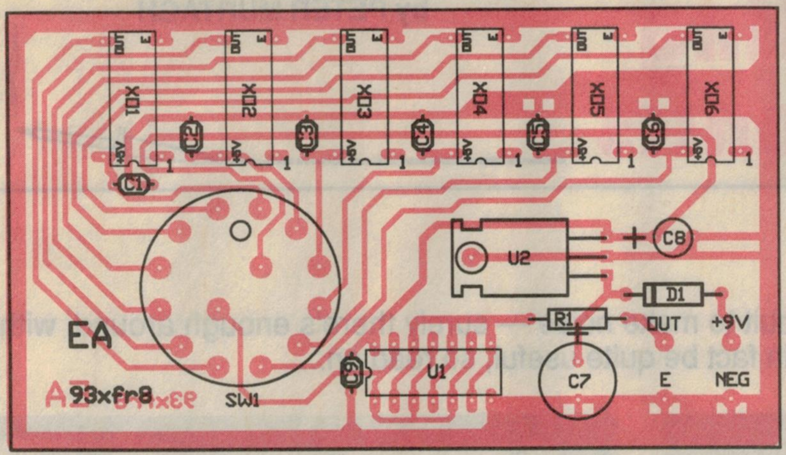
The complete project fits inside a medium-sized plastic utility box (UB3), measuring 130 x 68 x 41mm. Inside, all of the smaller components apart from the DC input connector and signal output connector mount on a small PC board measuring 98 x 56mm and coded 93xfr8. The PCB in turn mounts directly on the back of the rotary switch used for frequency selection, as you can see from the photos.

The PCB is not crowded, as there are not all that many components to be fitted. Although I used 14-pin IC sockets on the prototype for the crystal modules, to allow different modules to be tried out, there's no real need for this as the modules can be soldered directly into the board. (In fact if you *do* use sockets, as I did, you'll have to remove all but the first and last clips on each side, to let them mate with the board.) I also used a socket for the 74LS14 buffer chip, but this isn't really necessary either.

Wiring the PCB should be straightforward if you use the overlay diagram and the photo as a guide. Note that the overlay uses 14-pin IC outlines for the crystal modules, but the latter don't have an 'end notch' like an IC. Instead the corner of the module nearest pin 1 is left 'sharp', while the other three corners are rounded.



For those who wish to duplicate the front panel of the prototype unit, here is the artwork reproduced actual size.



And here is the PCB overlay diagram, to guide you in fitting all the components with the correct orientation. Sockets are not necessary for the oscillator modules.

Regulator chip U2 is simply clamped to the top of the PCB using a 3mm machine screw and nut. It doesn't require a heatsink, as the maximum current drain is only about 70mA.

I suggest you fit the rotary switch to the PCB first, as this may require a bit of manoeuvring to get the pins all mating with the holes. Then when these two major items are soldered together, it's easy to fit the remaining small parts. I fitted PCB pins where the DC input connections are made to the board, to simplify the fitting of a pair of wires connecting to the DC input socket.

Don't forget to cut the shaft of the rotary switch to a length of about 10mm from the threaded bush, and ideally file a flat on it to allow reliable tightening of the knob attachment screw. It would also be a good idea at this stage to check that the switch's stop washer (located under the star washer) is set to the correct position for six switch positions...

When you've completed the basic PCB assembly, it can be set aside while you cut the two holes in the case front panel — for the switch and output connector mounting holes. A photocopy of the front panel artwork can be used to locate the exact location of these.

The artwork can also be used to make a 'Dynamark' dress panel for the front panel, to give it a more professional appearance like the prototype. Once you've cut the holes in the front panel the Dynamark panel can be fitted carefully, and matching holes cut in it using a hobby knife.

The output BNC connector can then be fitted to the front panel, with its earth lug orientated so that it's directly below the centre active spigot. Then you can solder two short lengths of tinned copper wire to the two, and bend the earth lug until the two wires are parallel and about 7.5mm apart. This allows the wires to slip directly into their respective holes in the PCB, when the switch and PCB assembly is mated with the front panel from behind.

All you'll have to do then is fit the switch attachment nut and the knob, and solder the two output socket wires to the PCB, to complete the main assembly.

The final step is to cut a suitable hole in the end of the plastic case, to take the DC input connector. This can then be fitted, and two short lengths of insulated hookup wire (say 100mm long) used to connect it to the pins on the PCB.

If you screw the front panel into the case, your new multi-crystal frequency source should now be complete and ready for operation. ❖

PARTS LIST

Semiconductors

- 1 1N4001 or similar silicon diode
- 1 74LS14 hex Schmitt trigger IC
- 1 7805 three terminal 5V regulator
- 6 Crystal oscillator modules, TTL

Capacitors

- 7 0.1uF monolithic ceramic (C1-6, C9)
- 1 2.2uF 16VW TAG tantalum (C8)
- 1 330uF 16VW RB electrolytic (C7)

Miscellaneous

- 1 Plastic utility case, 130 x 68 x 41mm
- 1 Rotary switch, 2 pole 6 position
- 1 PC board, 98 x 56mm, code 93xfr8
- 1 Control knob, as desired
- 1 BNC socket, single hole panel mount
- 1 DC input connector, concentric type
- 1 47 ohm 0.25W 5% carbon resistor (R1)

Two PCB pins; 3mm x 10mm machine screw and nut; two 100mm lengths of hookup wire, or a 100mm length of two-conductor ribbon cable; if desired, six 14-pin DIL sockets.

NEW BOOKS

(Continued from page 50)

In addition, each book covers all emergency services like Police, Ambulance, Fire Brigade and the State Emergency Service. There is also a list of 'sorted frequencies' which shows the channel numbers of various services which operate more than one frequency — like the Police, State Emergency Service, Fire Brigade and Marine.

Each book lists all Police frequencies throughout Australia, for use if you travel interstate; so these frequencies are part of the common material. Also common are lists of the channels and frequencies for both marine and citizens band radio, and input and output channel numbers for Australian UHF repeaters. The information in each book was compiled and edited from the Australian Department of Transport's Master Frequency Register.

The review copies came from Dick Smith Electronics. They are available from all DSE stores. The books for New South Wales, Victoria, Western Australia, Queensland and South Australia cost $24.95, while that for Tasmania — with its far smaller list of users — is $19.95. The DSE catalog numbers are B-4102, 4104, 4106, 4108, 4110 and 4111, respectively. (P.M.) ❖

NEW KITS FOR EA PROJECTS

We have received the following information regarding the release of kits for recent *Electronics Australia* construction projects:

JAYCAR ELECTRONICS

Versatile 40V/3A Lab Power Supply (December 1993/January 1994): The Jaycar kit is complete with case, punched and silk-screened front and rear panels, PCB, transformer and all specified electronic components (including MKT capacitors and 1% metal film resistors). It carries the catalog number KA-1755 and is priced at $169.00.

DICK SMITH ELECTRONICS

EPROM Programmer (September-October 1993): The DSE kit is complete with pre-punched case, and has the upper PCB screen-printed in blue for a more professional appearance. It is also complete with two high-quality ZIF (zero insertion force) sockets for the EPROMs to be programmed. Carrying the catalog number K 3602, the kit is priced at $99.00.

ACS Decoder (September 1993): The DSE kit is of the 'short form' type, with the PCB and all parts necessary to built the module itself. Also included are the switch and other parts for fitting into the Digitor A-5235 radio, as described in the October issue. Carrying the catalog number K 5020, the kit is priced at $18.75.

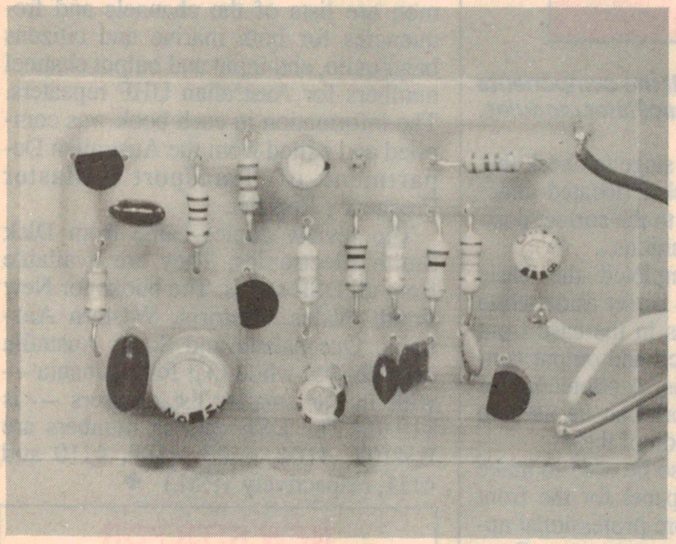
NOTE: This information is published in good faith, from information supplied by the firm or firms concerned and as a service to readers. Electronics Australia cannot accept responsibility for errors or omissions.

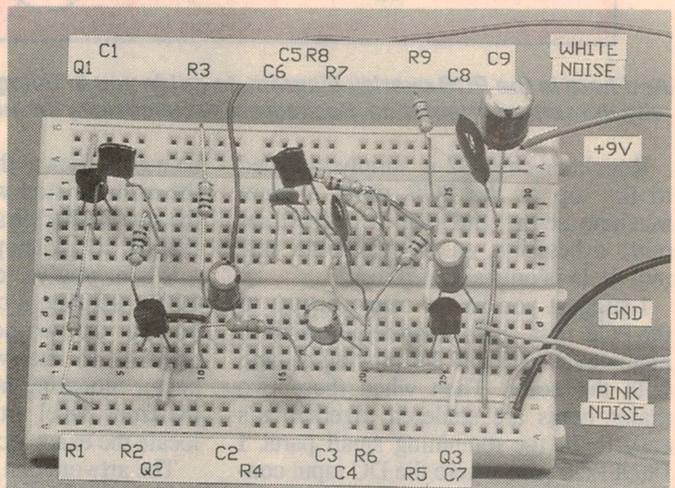
Experimenting with Electronics

by PETER MURTAGH

Noise maker

Why would anyone want to build a circuit to make noise — surely there's enough around, without adding to it? Well, a noise maker can in fact be quite useful, so read on...





Two versions of the noise maker are shown here. On the left is one made on a PC board, while on the right is one built on a prototype board — with most of the components identified.

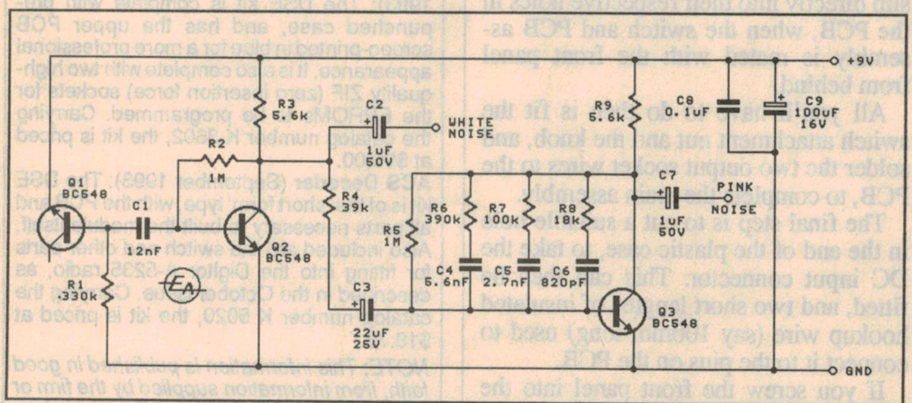
Because noise contains all possible frequencies scattered randomly across the whole spectrum, a noise generator can be used as a test instrument. By injecting noise into an RF amplifier you can evaluate its small signal performance, or by using noise with only lower frequencies you can test audio systems. The random nature of noise means that a noise generator can also be used to make wind-like effects in electronic music, or to simulate the sound of a steam engine.

Yet another use is to block out irritating sounds. We are all familiar with the way that the sound of an air conditioner, or a radio or TV tuned between stations, can mask unwanted background sounds — like barking dogs or traffic noise. The distinctive hiss of totally random tones from a noise generator can act in a similar way.

In general, noise is a random combination of an infinite number of sine wave components. By its nature, it is unpredictable. A zener diode when reverse biased produces just this sort of noise. So our circuit, rather than trying to minimise this inherent noise, simply amplifies it.

If you look at the schematic diagram you won't find a zener diode as such. Rather we have used as our noise source a reverse-biased base-emitter junction of a BC548 transistor (Q1). Such a junction goes into zener breakdown at about 7 - 8V — which lets us keep to our standard 9V supply rail. However, if you do increase the rail to a higher value, then you get a considerable increase in the noise produced across the junction.

Our sound generator can produce two different types of noise — white and pink. The difference between the various types of noise is the way in which the sound energy is spread across the frequency range. White noise has the same sound energy in the same *absolute*



The emitter-base junction of transistor Q1 is reverse-biased to make it produce 'white noise'. The negative feedback network around transistor Q3 converts this into 'pink noise' by rolling off the gain at 3dB per octave.

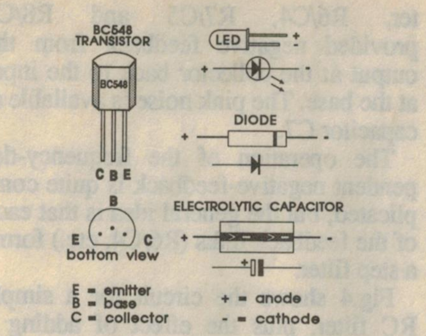


Fig.3: As usual, here is the pin-out diagrams for the common components which are used in our projects. Of course not all of them are used every month.

bandwidth, while pink noise has the same energy in the same *relative* bandwidth. Hence there is the same white noise energy in the two bands 100 - 200Hz and 2k - 2.1kHz because there is an absolute 100Hz increase in each. For pink noise to contain the same energy in each band, the second band would have to cover 2k - 4kHz to have the same (relative) 100% increase in frequency.

To convert the white noise into pink, we have used a filter to provide a 3dB cut per octave — which is only half the 6dB drop of a conventional RC network. A 3dB decrease means that each time the frequency is doubled (an octave), the sound energy is halved. This is equivalent to decreasing the voltage to approximately 70% of its original value (whereas in the RC network it is halved):

$$\begin{aligned} dB &= 20 \log(V2/V1) \\ &= 20 \times \log(0.7) \\ &= -3dB \end{aligned}$$

Pink noise, therefore, has more bass content than white noise, but — because it approximates the way our ear responds to increases in volume — pink noise appears to have a more uniform output level.

This 3dB per octave high frequency roll off is also used in the sound industry. This is done when sound systems are 'equalised', in order to restore the frequency balance for a particular setup. These are not generally equalised 'flat', but rather the 3dB roll off is introduced because this has been found subjectively to sound best.

But why a 3dB drop per octave? This figure makes sense because it keeps the energy per octave constant. Suppose a white noise generator produces a constant energy 'E' per each 10Hz increase in bandwidth.

Then the energy in the octave from 10 - 20Hz will be 'E', but in the next octave from 20 - 40Hz it will be '2E' (2 x 10Hz increase). That is, each successive octave will have *twice* the energy of the previous one because its bandwidth increase is twice as big. So, to keep the energy per octave constant, the energy in each new octave must be halved — which is exactly what occurs with a 3dB drop per octave!

This month's circuit will be limited to generating white and pink noise, with an output slightly less than 1V. It is designed to feed into last month's power amplifier module, in order to give sufficient volume. Next month we plan to give an extension to the board to show you how to modify the output in order to make special effects — like the sound of a steam engine or the crashing of waves on a beach.

Construction

The construction of this month's project is very straight-forward. Solder in the resistors and capacitors, then the three BC548 transistors. Make certain that you have the polarity of the four electrolytics correct. If you are using either strip-board or breadboard construction, take care to position the transistors also with the correct orientation.

The size of this month's PCB has been chosen so that it will slot into the grooves in a jiffy box. The 62mm length of the board will fit across a medium 130 x 68 x 41mm jiffy box. Wherever possible, we will try to make future PCBs fit the slots in standard size jiffy boxes. This will provide protection for the board when in use, as well as a suitable storage solution.

PARTS LIST

Miscellaneous

PCB 62 x 33mm, coded 94nm1
9V battery
hookup wire, solder, etc.

Resistors

All 1/4W, 5%

1	330k	R1	orange-orange-yellow
2	1M	R2,R5	brown-black-green
2	5.6k	R3,R9	green-blue-red
1	39k	R4	orange-white-orange
1	390k	R6	orange-white-yellow
1	100k	R7	brown-black-yellow
1	18k	R8	brown-grey-orange

Capacitors polyester (greencap)

1 12nF C1
1 5.6nF C4
1 2.7nF C5
1 0.1uF C8

Capacitors PC-mount electrolytics

2 1uF,50V C2,C7
1 22uF,25V C3
1 100uF,16V C9

Capacitors ceramic

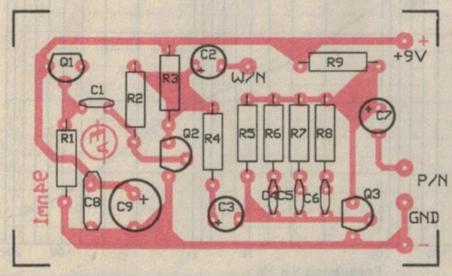
1 820pF C6

Semiconductors

3 BC548 NPN transistors Q1-Q3

Changes

You might find that you have to experiment with a few different transistors to get a suitable noise level (transistors tend to be *too good* these days!). So, if you complete the circuit and the DC voltages all measure correctly, but there is little or no noise, then suspect that your transistor Q1 might not have suffered reverse breakdown. This can be easily checked by increasing the supply voltage (e.g. by connecting two batteries in series). We found one of our BC548s needed 9.8V applied to become noisy, but most needed less than 9V.



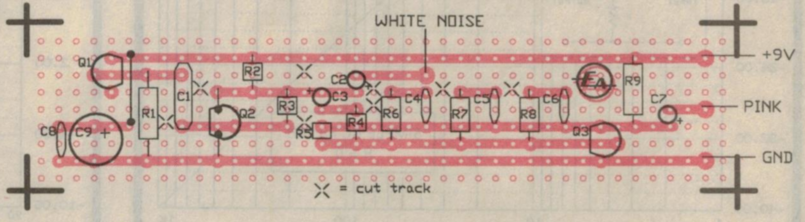
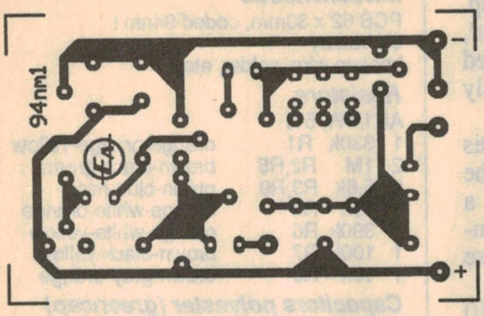


Fig.1: The component layout for the PCB. We have been able to keep the circuit quite simple by assuming that you will plug its output into last month's power module. Only simple pre-amplification is therefore done on the noise maker.

Fig.2: The layout diagram to build the circuit on strip-board. As usual, make sure that you break the copper track at all the locations marked as 'cut track'.

Experimenting with Electronics



The PCB pattern is given here actual size for those who wish to etch their own board.

As mentioned earlier, you can increase the noise output substantially by raising the supply rail well above the reverse breakdown voltage.

How it works

When you bias a PN junction in the reverse direction, the majority carriers (holes in the *p*-side and electrons in the *n*-side) move away from the junction, resulting in the barrier or depeletion layer becoming thicker.

Because there are now so few electron-hole pairs in the depletion layer, only a very small current can be detected. This is called the leakage current. However, once the bias reaches a certain threshold voltage, there is a substantial rise in this leakage current. The voltage at which this occurs is called the *avalanche* or *breakdown* voltage. At this point electrons acquire sufficient energy to knock other electrons out of the structure, causing the large increase in current.

Provided that this current doesn't generate more heat than the component can dissipate, this process is non-destructive. In fact, because a near constant voltage occurs across the diode during reverse breakdown, it is the basis of the operation of the *zener diode*. As you probably know, zeners are connected between two points in a circuit to maintain a constant voltage between them.

As mentioned earlier, once we have exceeded the threshold voltage for the the reversed-biased emitter-base junction of transistor Q1, the thermal noise of the current flow gives us a source of white noise. This is amplified through a simple one-transistor amplifier (Q2), and the white noise output is available at capacitor C2.

Resistor R2 biases the transistor on, and because it is attached to the junction of Q2's collector and resistor R3 — rather than directly to the 9V supply rail — it also provides negative feedback to stabilise the circuit.

To convert white noise into pink, we use a filter network to drop the signal by 3dB per octave. Because the filter decreases the signal substantially, we need to re-amplify it. Both these processes are achieved with transistor Q3. As an amplifier, it is set up in a similar manner to transistor Q2; and as a filter, R6/C4, R7/C5 and R8/C6 provided negative feedback from the output at the collector back to the input at the base. The pink noise is available at capacitor C7.

The operation of the frequency-dependent negative-feedback is quite complicated, but the general idea is that each of the feedback links (R6/C4, etc.) forms a step filter.

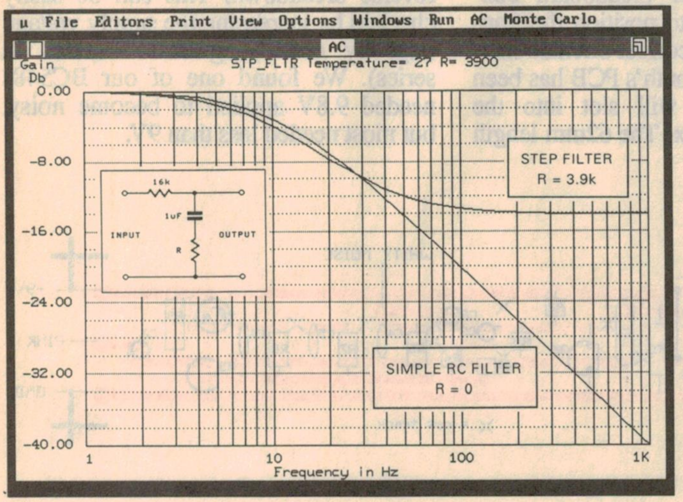
Fig.4 shows the circuit for a simple RC filter, plus the effect of adding a suitable value resistor 'R' in series with the capacitor. You can see how this extra resistor reduces the slope of the roll-off from 6dB to 3dB — but only for a limited bandwidth — before it tapers off to zero. It is easy to see why it is called a step-filter!

Now, in our pink noise circuit, we have three such step filters. Each successive one is designed to begin operation at the point that the previous one tapers off. Hence, we end up with the gain as shown in Fig.5 — a 3dB roll-off over the desired frequency range. You can see the slight bump at 2kHz where we could have added yet another RC link to further smooth out the gain response.

Transparencies

As usual, a high contrast, actual size transparency (negative) for the PCB used in this circuit is available for only $2. This will allow you to etch your own printed circuit board. This special price applies for transparencies for all projects in this series only. Write to *EA*'s reader services division.

Happy experimenting — and please send us your comments on the circuits we have published, as well as ideas for future projects. ❖



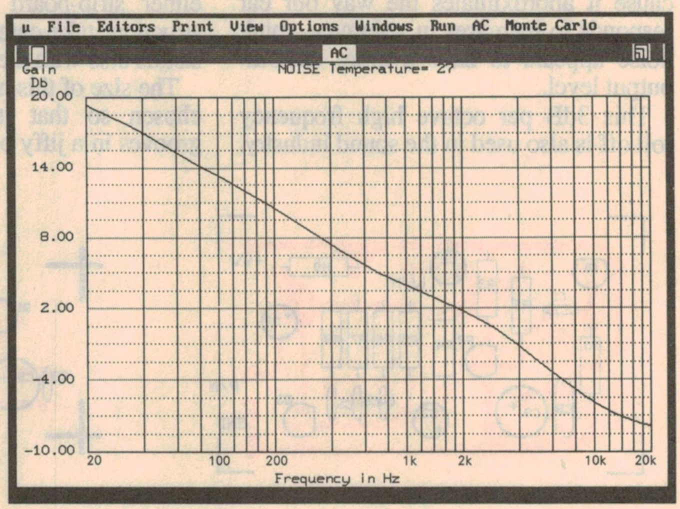


Fig.4 (left): Here we have the output for a simple step filter, as drawn by a computer simulator. Three of these filters are used to convert the 'white' noise into 'pink'.

Fig.5 (right): This printout shows how the pink noise rolls off at approximately 3dB per octave. The slight bumps in the output occur where the step filters don't quite mesh together.

AC voltage finder and electrical tester

Both Dick Smith Electronics and Jaycar have released handheld voltage finders/testers. The DSE model is an AC voltage finder only, while the Jaycar model also locates DC voltage and tests electronic components.

by PETER MURTAGH

Both the DSE model DX-200 and the Jaycar Meet model 48NS are similar in size, around 120mm long, and fit comfortably in the palm of your hand.

Both are powered by two 1.5V watch batteries and both can detect the electromagnetic field generated around a 'live' AC lead without direct contact, giving you a visual plus audible indication. The DSE model is simpler, being designed for the one task only.

Because both models also react to the presence of static electricity, they can be easily checked to see if they are working by rubbing them against your jumper or hair!

DSE AC voltage finder

The DX-200 detector will react to any AC voltage above 120V, when it comes near any live wire. Because no contact with live wiring is required, it has an insulated probe. When a button in the middle of the unit is depressed, the presence of AC triggers a flashing LED and an audible buzz.

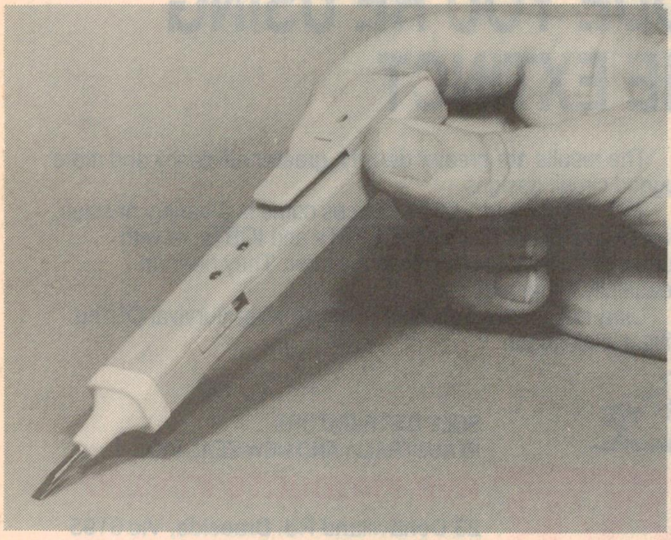
We found that the buzzer sounded when the tip of the probe was about 10mm from the faceplate of a power point, and slightly less than 10mm from a live power cord. The tester reacted to the presence of the 240V AC field, whether or not an appliance was plugged in or being used. Because it reacts in the vicinity of the AC field, it didn't discriminate between the 'active' and 'neutral' terminals on the power point. However, turning the power point switch on and off did affect the volume of the buzzer.

Of course, the sensitivity of the voltage finder and its ability to find a live wire was very much dependent on how far away the probe was from the live wire, and what sort of insulating material masked the field. For example, it couldn't locate the wiring running to a powerpoint behind a divider wall in the *EA* office, but it could find the wires behind a wooden panel in our lab.

Meet 48NS

The Jaycar Meet 48NS model has a three-position slider switch, which doubles as both on-off and high-low sensitivity control. (The positions are labelled 'O', 'L' and 'H'.) Like the DSE model, the 48NS gives both visual and audible indications when it detects a field, but it has two LEDs to show relative strengths — red and green. When the green glows for the stronger signal, the buzzer also sounds.

Because the 48NS also detects DC voltage and tests electronic components, its probe is an exposed metal tip, shaped like a screwdriver blade (though it is not recommended that it be used as one!). Even with the unit switched off, it will



The Jaycar model reacts automatically to various fields, with the option of high or low sensitivity. Because DC measurements require electrical contact, it has an exposed metal tip.

The DSE voltage finder will react in the vicinity of an AC field when the pushbutton is pressed. Note its safety-conscious insulated probe.

still detect the presence of 240V AC fields if the tip makes direct contact with a wire. The red LED glows brightly if the wire is live, and glows weakly if it is neutral. With higher sensitivity, the probe reacts strongly to merely being *near* a live wire, so does not distinguish which wire is which.

Because the exposed tip of the tester is 16mm long, I feel that contact with a live wire could be quite dangerous. A shorter exposed tip would be far safer. And the longer tip has not been provided to allow you to test for the active slot on a powerpoint — the round stem of the blade prevents it being inserted far enough in to make electrical contact. This could also be a danger — you might think that you had located the neutral wire because the buzzer did not sound, when you had in fact failed to make contact with the active!

Other uses

The 48NS can also detect the presence and polarity of DC voltage, test electronic components, and check for continuity. It does this by completing a circuit via the operator, who must must both touch an exposed metal plate on the side of the tester and also hold the component being tested. The circuit will normally be completed via the operator's body.

Continuity testing in the 'off' position causes the red LED to glow, while the green LED and buzzer are activated on higher sensitivity settings. A similar result is obtained when the probe touches the positive terminal of a battery, while the operator touches the negative — but not if the contacts are reversed. This lets you determine the polarity of a battery.

The tester can also be used for diodes (and by extension, for transistors). This applies to signal diodes, power diodes and LEDs, though the different types of diode required different sensitivity levels.

To get a response, the probe must come in contact with the negative cathode and the operator's finger with the positive anode. For example, with a 1N4148 signal diode, the red LED glowed on the 'O' setting, with the green LED glowing and the buzzer beeping on 'L'. It could not discriminate between the anode and cathode on the 'H' setting, as it beeped for both.

In contrast, the terminals of a yellow LED could only be identified on 'H'; while a 1N4002 power diode, a BC548 and a BC549 transistor all needed the 'L' level. For the NPN BC548, the probe produced a beep only when it touched either the collector or emitter, with a finger contacting the base. For the PNP BC558, the probe had to contact the base. That is, for both diodes and transistors, the probe had to touch the N-doped section of the PN junction, while the operator touched the P-region, to get the discriminating beep.

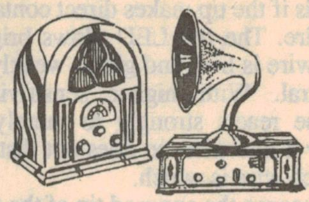
Summarising

Both testers clearly indicate the presence of AC fields, provided that they are very close to a live wire. This makes them very useful for warning you that you are working near live wiring. But neither detector could locate a live wire behind a concrete or plaster wall, or if the wire was in metal conduit — this would seem to limit their usefulness in locating hidden wiring behind most walls. The 48NS model also provides very convenient continuity and diode testing.

The DX-200 AC Voltage Finder is available from all Dick Smith Electronics stores for $16.95 (Cat. No. Q-1531); the Jaycar stores are selling the Meet Model 48NS Multifunction Electrical/Electronic Tester for $15.95 (Cat. No. QP-2260). ❖

Vintage Radio

by PETER LANKSHEAR



Capacitors in vintage radio — 1

The electronics industry is the major user of capacitors. For the earliest equipment existing types of capacitor were used, but in time the radio industry developed its own varieties, each with individual characteristics. In this article and those which follow, we will look at the different types found in vintage radios and suggest ways of dealing with faulty units in restoration projects.

Capacitors are indispensable components, performing a wide variety of functions including circuit tuning, DC blocking, bypassing and hum filtering. They are classified according to the dielectric used in their construction, the most commonly encountered in early receiving types being air; waxed, oiled or varnished paper; mica and ebonite. Glass and oil dielectric types were also used in early transmitters, but it may come as a surprise to realise that the types in regular use prior to 1930 are rarely found in modern equipment.

Capacitors can deteriorate or fail, and are the least reliable electronic components, with the situation aggravated by their being also probably the most prolific source of intermittent faults. Consequently, a sizable percentage of service and restoration work centres around capacitors.

Fortunately, modern replacement capacitors are significantly more reliable and stable than their predecessors. Each type has its own characteristics, and it is very important to select an appropriate substitute — not only for capacitance and working voltage, but also for its dielectric properties and behaviour.

Around 1929 appeared the first of what was to eventually become an extremely important class, the *electrolytic* capacitor. Later in the decade came ceramic and polystyrene dielectrics. Without the multitude of types developed from these pioneers, electronic equipment would be very different today.

Postwar, other synthetics were developed and were found to have excellent performances. By the end of the valve era, capacitors with mylar, polyester, polythene and polycarbonate dielectric were coming into in common use.

Shocking event

The first capacitor, the glass Leyden jar, was invented about 250 years ago. This, by the way, is the origin of the obsolete unit of capacitance the 'Jar' — equal to 1.1 nanofarad — although one authority gives the capacitance of a one pint Leyden capacitor as 1.4 nanofarad. Credit for delivering the first ever man made electric shock is associated with the discovery of the Leyden jar. The story goes that a research group at Leyden University in Holland were using a static electricity machine connected to a glass jar with an external conductive coating and containing water. Electricity was then thought to be a 'fluid' and therefore it might be possible to store it in a container. Someone grabbed the connecting leads to the jar and discovered forcibly that it did indeed store electricity!

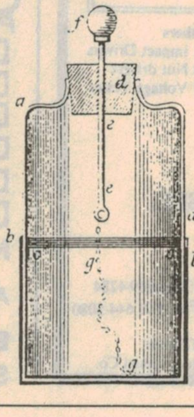


Fig.1: The Leyden jar capacitor, which has been around for well over 200 years, was one of the few types which successfully withstood the high voltages of spark transmitters. This 19th-century drawing shows the construction, with tinfoil extending halfway up the sides (inside and out) of a glass jar. A metal chain made contact with the internal foil. There is no explanation of how the foil was pasted inside a jar with such a narrow neck! Some versions solved this problem by half-filling the jar with fine metal shot, to form the inner 'plate' of the capacitor...

The classic Leyden jar consisted of a large glass jar, with the lower part of the exterior covered with tinfoil forming one electrode. The other electrode was a matching layer of foil inside the jar, with contact made by a metal chain suspended from the lid. Sometimes metal shot was used inside the jar instead of foil, to form the inner electrode.

Tradition has it that Hertz used Leyden jars for the capacitors in his experiments, to confirm James Clerk-Maxwell's predictions about the existence and behaviour of electromagnetic waves. Later, Sir Oliver Lodge used Leyden jars in his research into 'syntony', or tuning of electromagnetic radiations. Notwithstanding their bulk and difficulties in stowing, Leyden jars reliably handled very high voltages, and sets of them were often used in marine spark transmitters.

A more convenient capacitor for spark transmitters used flat glass photographic negative plates and tinfoil electrodes, often housed in an oil-filled container. Glass capacitors are still used for specialist equipment, but they are rarely found in vintage receivers.

Although the vintage radio enthusiast will not encounter many glass capacitors, there is one type that may be found in very early home built receivers using neutralised triode RF amplifiers. One form of primitive neutralising capacitor consisted of a piece of thin glass tubing, wrapped with tinfoil forming one electrode. Inside the tubing was the other electrode, a piece of heavy gauge wire whose position could be adjusted to vary the capacitance.

Another pioneer capacitor, the air dielectric type, is the most efficient and

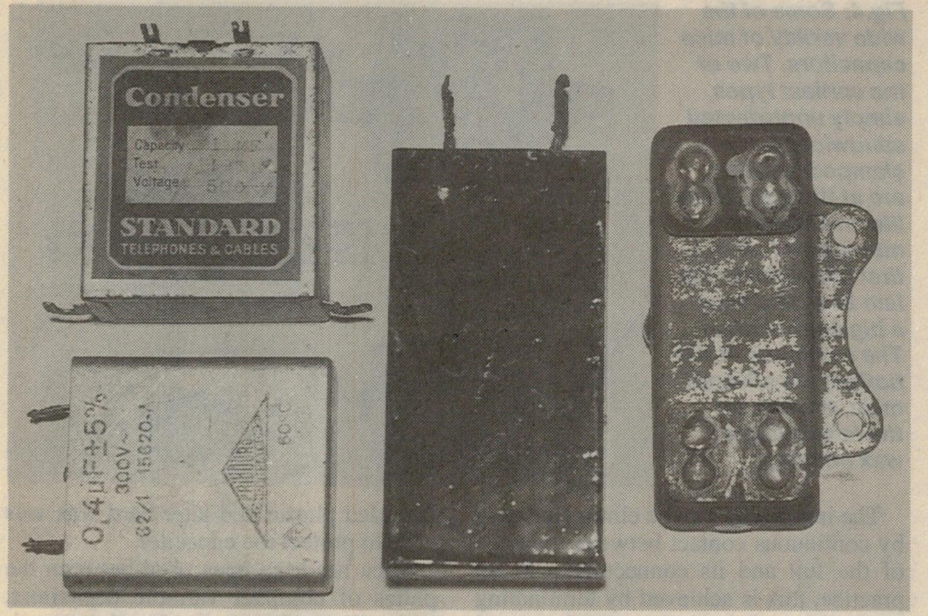


Fig.2: Early paper capacitors were generally sealed in metal cans, with varying degrees of success in keeping out moisture. Often several capacitors would be included in the one container, like the typical Atwater Kent unit on the right.

stable variety of all, and has of course been used extensively for variable tuning capacitors which hardly need any description. Air dielectric is ideal too for preset trimmers, one of the best known being the Philips 'beehive' type. Although used in some older test equipment, fixed air dielectric capacitors were not normally used in receivers.

What surely must have been physically the largest capacitor ever made had an air dielectric. This was the 1.8uF spark capacitor of the Marconi 300kW transmitter installed during 1906 at Clifden in Ireland, for the trans-Atlantic link to Glace Bay in Nova Scotia. Everything about this transmitter was awe-inspiring. Its capacitor, capable of handling 150,000 volts without flashing over, was assembled from 1800 galvanised steel sheets, each 30 feet by 12 feet and spaced 12" (300mm) apart. The array was housed in a shed the size of a warehouse, 350 feet long by 75 feet wide and reaching 33 feet at the eaves!

At the frequencies we use today, such large dimensions would make the capacitor useless; but Clifden transmitted on a wavelength of about 6.5km (i.e., about 46kHz). That enormous capacitor remained in service until 1920, when valves were installed in the transmitter.

The waxed-paper dielectric capacitor was used in telephone and telegraph equipment before the advent of radio. Paper's earliest use as a dielectric in radio was in the primary capacitors for induction coils, serving the same purpose that they still do in automotive ignition systems. As equipment became more complex, the paper capacitor was used increasingly wherever compactness with a high capacitance was required.

Impregnated paper is an inexpensive and reasonably effective material, but the dielectric constant is not constant at high frequencies, and it has some losses. Nonetheless, from the late 1920's until about 1960, paper capacitors were the most common type used in receivers. Various waxes and oils have been used, including paraffin wax, castor oil, mineral oil and petroleum jelly and later, some synthetic oils and plastics.

The most effective of all synthetics has created a serious environmental problem. Polychlorbiphenol (PCB) is the ideal insulating and impregnating oil, and was used extensively in capacitors, transformers and switch gear. Unfortunately the characteristics of extreme stability and indestructibility, which made it such an excellent dielectric, have also made it a toxic ecological disaster. The use of PCB is now illegal and any supplies have to be destroyed under controlled conditions. About the only way to deal with it is by burning in very high temperature kilns. Australia and New Zealand recently found it necessary to export their stocks to France for destruction in a specially built plant.

Fortunately PCB is not likely to be encountered in receiver components, but Australian manufacturer Ducon did use it in some of their metal-cased industrial grade capacitors.

Paper can exhibit fairly serious dielectric absorption losses, a phenomenon in which it takes time to accept or release a charge. This has the effect of reducing apparent capacity at high frequencies, and for this reason paper capacitors should not be used in tuned circuits. This trait works in reverse, sometimes causing a disconnected capacitor to apparently recharge itself. Consequently, to avoid nasty shocks, out of service filter capacitors from high powered valve transmitters were stored with a length of wire connected between their terminals.

The earliest method of paper capacitor construction was in the form of a multilayer sandwich, built up with alternate layers of paper and tinfoil. By 1910, the modern form of construction was common. Long sheets of thin paper and tin or aluminium foil are forced into close contact by rollers and the required lengths are rolled tightly to form the familiar general purpose tubular paper capacitor.

Voltage ratings are raised by increasing the number of layers of paper between foils. High capacitance units are wound flat, much like a bolt of cloth, often with several sections connected in parallel to achieve the required capacitance. After winding they may be then sealed in metal boxes.

Pinhole problems

One problem with paper as a dielectric material is that it is apt to have random pinholes which can lead to a rapid failure. On the assumption that two holes in adjacent sheets are unlikely to coincide, an extra ply is included to reduce the chances of breakdown, but increasing the finished size of the capacitor.

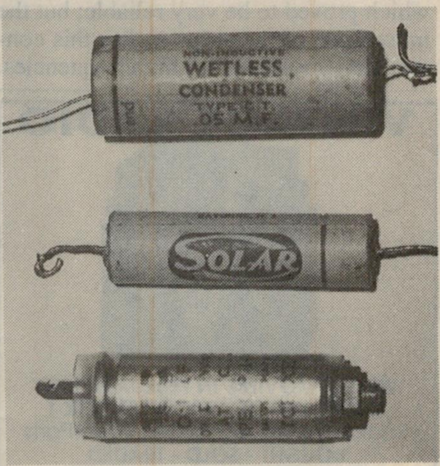


Fig.3: A selection of tubular paper capacitors, the most common type used in receivers from around 1930 to 1960. The top example is a waxed cardboard cased type, prone to leakage. Hard wax shells (centre) were a considerable improvement, but most reliable were the metal-cased type with plastic seals (bottom).

In the late 1930's, German and English research developed the space saving *metallised paper* capacitor. Finely divided aluminium or zinc was deposited directly onto the paper, and there was no safety ply. Instead a voltage, applied after metallising, effectively vapourised any metal film at weak spots or holes in the paper, where there was a breakdown. The result was a capacitor significantly smaller than its multi-ply equivalent.

Metallised paper capacitors have proved often to have had lower insulation resistance than the conventional variety but are immune to voltage spikes that would ruin a conventional capacitor.

The biggest problem with paper dielectric capacitors in service is effective sealing against moisture. Unless they are extremely well sealed, moisture will penetrate the layers, seriously reducing insulation resistance. Initial specifications were typically for resistances of hundreds of megohms per microfarad, but it is not uncommon for this to drop to a few thousands of ohms.

Various casings, including waxed cardboard, hard wax, plastic, aluminium and steel have been used, with varying degrees of success. Least effective was probably the most common — the waxed cardboard tube; but other types of casing are not immune from trouble either.

Another problem with tubular paper capacitors was lead termination. Rolled capacitors originally had thin metal strips wound in with the foils, a method which proved to be very reliable; but the inductance of the strips makes this construction unsuitable for high frequencies.

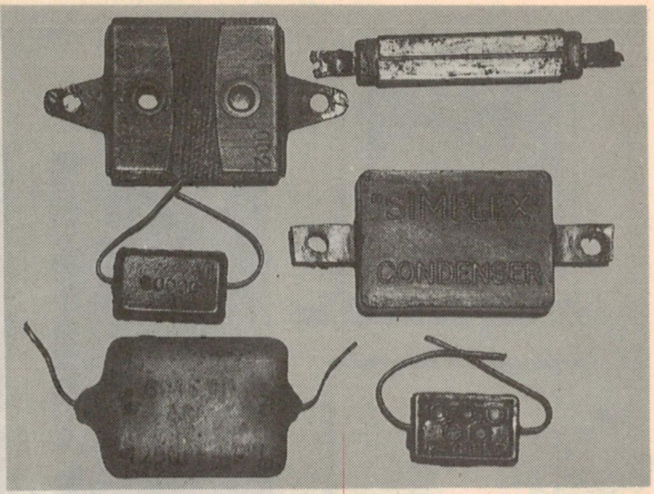


Fig.4: Some of the wide variety of mica capacitors. Two of the earliest types, simply unprotected sandwiches clamped together, are at the top. Bakelite and Micalex mouldings (centre) first appeared in the late 20's, and were a big improvement. The examples at the bottom are silvered mica, the one on the left having a wax coating.

The inductance can be eliminated only by continuous contact between the edge of the foil and its connecting lead. In practice, this is achieved by terminating the lead in a flat spiral or metal cap and securing it in close contact with the projecting foil edges.

Tinfoil can be soldered, but contact to aluminium foils is difficult and often is dependent on pressure provided by the crimped edges of the protective sleeve or a wax or composition plug. Poor contact can of course, produce sporadic behaviour and the all too-familiar-complaint of an intermittent fault.

A natural dielectric

The use of mica capacitors also predates the beginnings of radio communication, and for a long period these were regarded as premium components. Mica is one of the most efficient and effective dielectrics, with a high dielectric constant and extremely high electrical resistance. It is also temperature stable and has very low losses even at microwaves.

Mica is also unusual in that it is a naturally occurring material. Unlike paper, dielectric absorption is negligible and efficiency is very high. Finely laminated, it can be readily split to any required thickness — although brittleness and the relatively small size of the sheets limits methods of construction.

Mica capacitors are constructed by the traditional stacking of metal foil and mica plates not more than a few centimetres square, to provide capacitances ranging from 5pF or so to 0.1uF. Of course, the thinner the mica sheets, the greater is the capacitance — but the lower the voltage that the capacitor will handle. The assembly is clamped together between two pieces of fibre, and leads or tags are connected to the foil.

Initially, mica capacitors were often left unprotected. But from about 1930, moulded plastic and later hard wax was used to protect the capacitor.

Mica has long been used between the plates of compact variable capacitors, and will be frequently found in semi-variable trimmers and padders.

A problem is encountered with the sandwich method of mica capacitor construction. No matter how carefully they are assembled, minute quantities of air become trapped between the foil and mica. This air reduces the capacitance, and can become ionised if more than about 500 volts is applied, leading to rapid failure. To reduce this possibility, high voltage mica capacitors were frequently assembled in a series-parallel arrangement to reduce the voltage handled by individual sections.

The *silvered mica* capacitor is one solution to the problem of trapped air. Instead of using foil electrodes, a thin coating of silver is deposited on the mica, much as with the metallised paper capacitor, effectively eliminating any air.

Silvering reduces the physical size and improves stability. However silvered mica capacitors have their own breakdown problems. After a period of time, which may be only a few hours or in some cases many years, a silvered mica capacitor connected across a DC potential may suddenly develop a short circuit. The problem is the result of what is known as *ion migration*, whereby a microscopic branched growth or 'dendrite' of silver penetrates the mica and bridges the electrodes. As we shall see when we cover servicing of capacitor faults, receiver manufacturers were not always aware of this possibility.

The capacitor types that we have covered so far had their origins in the 19th century and earlier, well before the development of radio. But next month we look at electrolytic, ceramic and polystyrene capacitors, which were developments of the radio industry itself. ❖

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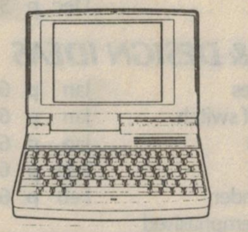

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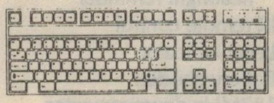

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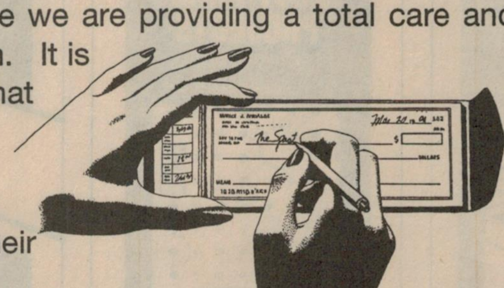

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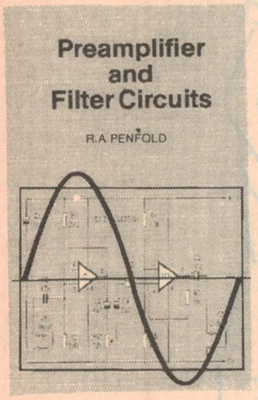

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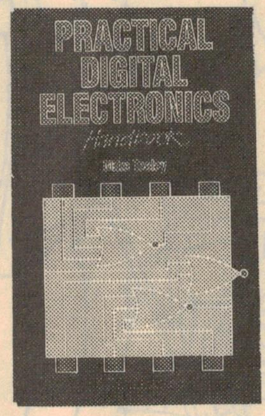

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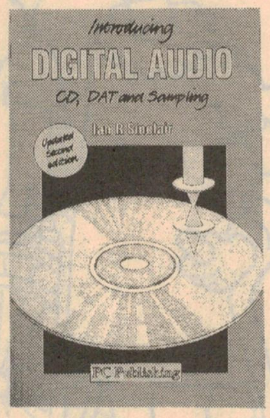

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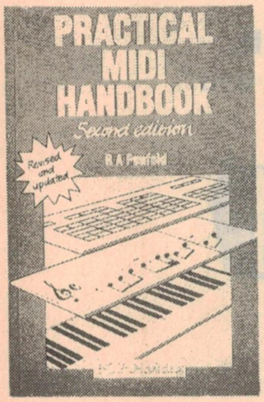

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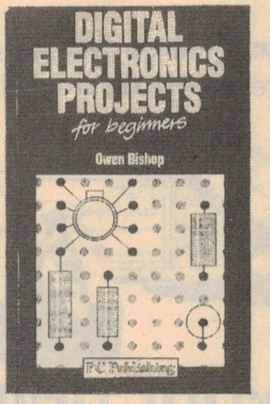

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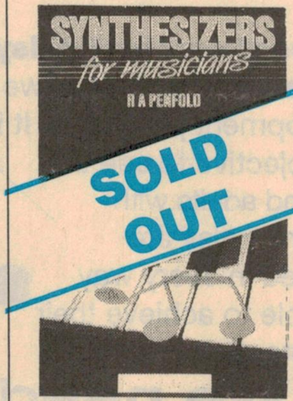

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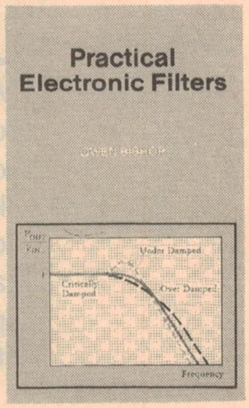

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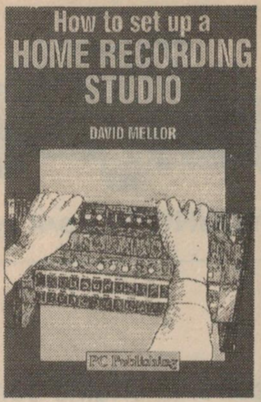

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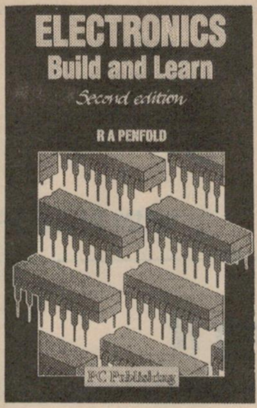

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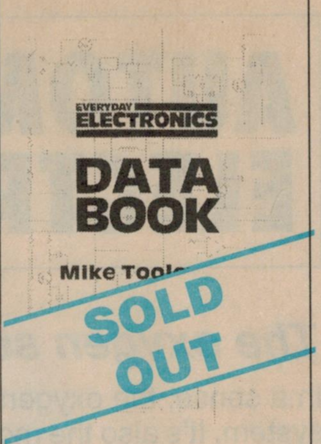

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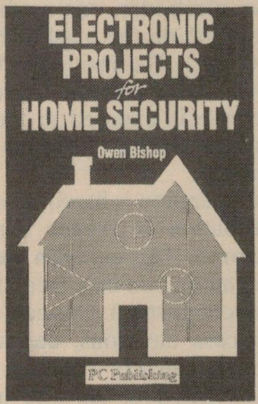

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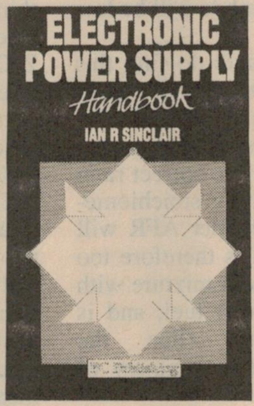

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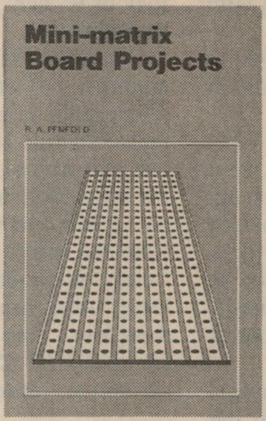

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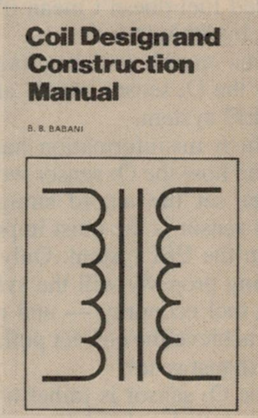

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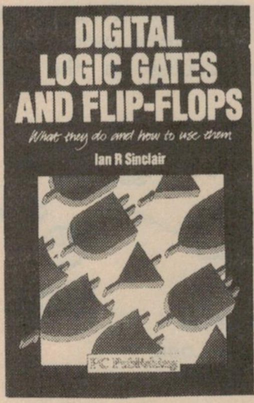

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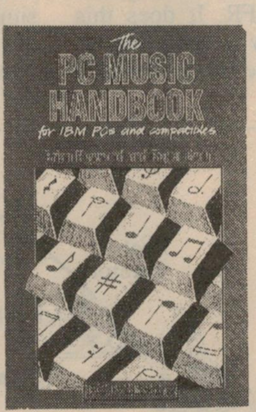

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AUTOMOTIVE ELECTRONICS

with MAJOR AL YOUNGER (USAR, Ret.)

The oxygen sensor — and testing it

In a sense, the oxygen (O_2) sensor is the 'king' of all sensors used in an electronic engine control system. It's also the most misunderstood — so this time around we're going to look at the operation of this important device. I've also designed a simple low cost tester for these sensors, and a description of this is included.

If your vehicle is fitted with a catalytic converter, it also has an oxygen (O_2) sensor (Fig.1) fitted to the exhaust manifold. (Just because your car uses unleaded fuel doesn't mean it's fitted with one, by the way.)

This month we're going to look at how the O_2 sensor works, and its role in the EFI system.

Much misinformation has been written on how the O_2 sensor works, so we'd better set the record straight, first up. This sensor is the most important one of all in the EFI system. Only if it's functioning properly will the system give its best fuel economy — and most important, achieve the correct pollution control of exhaust gases.

The O_2 sensor is rather unique, and is often called a *lambda* sensor from the Greek letter lambda (λ), which is commonly used to denote the ratio:

$$\lambda = \frac{\text{actual air/fuel}}{\text{air/fuel at stoichiometry}}$$

So λ will have a value of 1.0 at stoichiometry — i.e., where the AFR is 14.7:1. When the air/fuel mixture (AFR = air/fuel ratio) has too much air (i.e., it's 'lean'), lambda will be *greater* than one (>1). Conversely, when the mixture has too *little* air (i.e., it has too much fuel, or is 'rich'), the lambda will be less than one (<1).

Confused? Many people do find this confusing, so let's go over the concept of AFR again briefly. An AFR of 14.7:1 means there's 14.7 parts of air, to every one part of fuel. This is the correct ratio for efficient combustion, or stoichiometry. A mixture with a higher AFR will have too much air, and is therefore too 'lean'; on the other hand a mixture with lower AFR has too much fuel, and is therefore too 'rich'. (See the LEAN/RICH Chart for a summary of the various terms used.)

O_2 sensor types

Two types of O_2 sensor are used today, based on the use of active oxides of materials. One type (the most common) uses zirconia oxide (ZrO_2); the other uses titanium oxide (TiO_2). In each case the sensor is designed to output a DC voltage, depending upon the engine's AFR. It does this by responding to the level of unused oxygen (O_2) remaining in the engine's exhaust gases.

In essence, the sensor consists of a thimble-shaped element of ZrO_2 with thin platinum electrodes, one on the inside and the other on the outside of the ZrO_2 itself (Fig.1). The inside electrode is exposed to the outside air, while the outside electrode is exposed to the engine exhaust gas, through a porous protective 'overcoat'.

The sensor operation is based upon the relative distribution of oxygen ions on the two electrodes. (An ion is an electrically charged atom, you may recall from your school chemistry.) Oxygen ions have two excess electrons, and since electrons are negatively charged, this means that oxygen ions are also negatively charged.

The ZrO_2 has a tendency to attract these oxygen ions, and they accumulate on the ZrO_2 surface, just inside the platinum electrodes.

The platinum electrode on the *reference* (outside air) side of the ZrO_2 will be exposed to a much higher concentration of O_2 ions than the exhaust side, simply because most of the oxygen in the air-fuel mixture is used up by the combustion process in the engine.

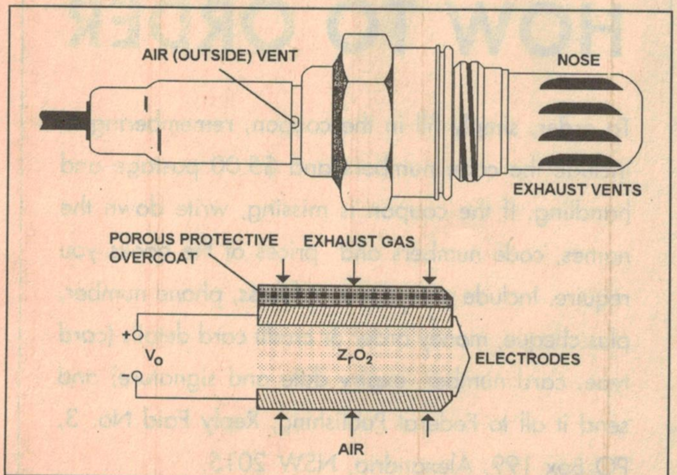


Fig.1: A typical oxygen sensor and its operating principle.

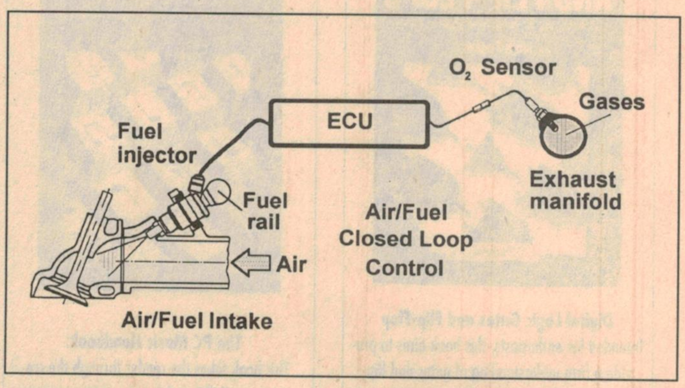


Fig.2: The sensor forms part of the 'closed loop' AFR control.

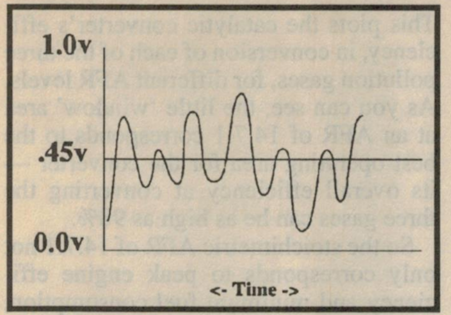


Fig.3: The oxygen sensor output for a 'normal' average AFR of 14.7:1.

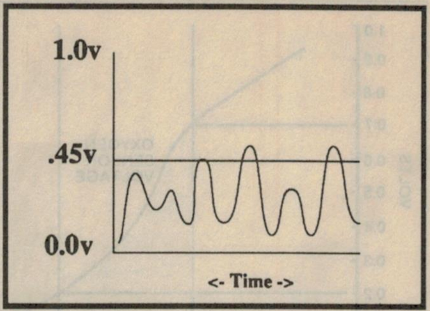


Fig.4: When the mixture is too lean, the average sensor output is lower.

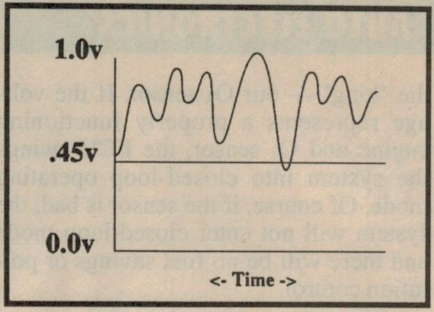


Fig.5: And when the mixture is too rich, the average sensor output is higher.

Therefore, an electric field will be set up across the ZrO_2 material and a voltage, V_o, is generated between the two platinum electrodes.

The magnitude of this voltage depends upon two things: the concentration of oxygen in the exhaust gas, and the sensor's *temperature*.

Here's where some get confused, because the *greater* the oxygen content in the exhaust, the *lower* the sensor's output voltage V_o. This is because the more oxygen present in the exhaust, the smaller the *difference* between the exhaust gases and the outside air, in terms of oxygen concentration. So the sensor voltage *falls*.

By the way, the sensor is arranged so that the platinum electrode in contact with the outside air is connected to the sensor body (and hence the manifold, and vehicle frame), while the electrode in contact with the exhaust gases is connected to the sensor's output terminal. So the output voltage V_o is positive with respect to frame, and becomes smaller or *less positive* when the oxygen content increases (when the mixture is lean).

Atmospheric pressure also has an effect on the sensor operation. This can be mostly overcome by maintaining the engine's exhaust system 'back-pressure'. So the exhaust system must always be in good nick. A leak between the catalytic converter and the exhaust manifold will degrade operation.

Desirable characteristics

Here are the characteristics we'd expect from the ideal oxygen sensor:

1. It should be *sensitive* to changes in oxygen level in the exhaust gases, at the level of stoichiometry. In other words, the output voltage should change fairly rapidly, at this level.
2. It should be *fast in response*, changing its output voltage quickly in response to a change in exhaust gas oxygen level.
3. It should produce a large voltage change, to reflect the difference between lean and rich conditions. This is to make it easier for the ECU to respond to the sensor's output.
4. And finally, its output voltage should be as stable as possible with respect to exhaust temperature.

To insure the last of these, automotive engineers select the ideal position of the sensor, relative to exhaust temperature and back-pressure.

All practical sensors exhibit a phenomenon known as *hysteresis*, which is a built-in switching delay. This cannot be overcome physically, but is taken into account in the ECU firmware.

Switching characteristics

Now this is where many people become confused, so I'll try to make it clear. The O_2 sensor has its own switching characteristics, which should not be confused with its normal response in reacting to a lean/rich condition.

Temperature affects the sensor's switching time and output voltage. For proper voltage output, the temperature should be maintained between 350 to 800°C. Note that I just said *temperature*, because some sensors do not depend upon *exhaust temperature* alone. Some, like Ford and Volvo, have sensors heated by battery voltage.

The sensor's switching speed changes as a function of temperature. At 350°C it takes 100ms (0.1 second), while at 800°C it takes only 50ms (0.05 seconds). So any allowance made in the ECU for the sensor's switching time has to take account of its temperature.

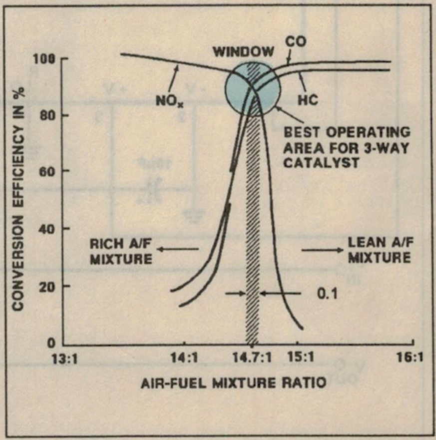


Fig.6: The optimum AFR of 14.7:1 coincides with a 'window' for best operation of the catalytic converter.

Now that we understand the way the O_2 sensor works, and its switching characteristics, let's see how it works in the EFI system.

Sensor functions

It's important to realise that this 'king' of sensors works only as part of a closed-loop feedback control system, to control the engine AFR.

What does 'closed loop' mean? It means that the ECU continuously monitors the engine's operation — by means of the O_2 sensor and others — and uses this 'feedback' information to make any changes which may be needed, to ensure correct operation. In particular if the mixture is too lean or too rich, the output of the O_2 sensor will feed this information back to the ECU, which can then make the appropriate change to the width of the pulses it feeds to the injector solenoids, to correct the situation and maintain stoichiometry — for the most efficient engine operation and minimum pollution.

With most ECU's, the system is ready to enter this closed-loop mode of operation when the following conditions have been satisfied:

- The engine has reached its operating temperature;
- There has been no significant change in throttle setting;
- The O_2 sensor is heated and functioning; and
- All ECU sub-systems are functioning correctly.

Note that systems with heated O_2 sensors may enter closed loop mode with the vehicle stationary, and the engine still idling.

The ECU verifies that these conditions for closed loop operation have been reached, then looks for an output from

the 'king' — our O_2 sensor. If the voltage represents a properly functioning engine and O_2 sensor, the ECU swings the system into closed-loop operating mode. Of course, if the sensor is bad, the system will not enter closed-loop mode and there will be no fuel savings or pollution control.

In more detail

OK, it's closed-loop time and our O_2 sensor must go to work. The basic components of the AFR closed loop are the sensor itself, the ECU, the fuel injectors and of course the engine (Fig.2).

When the sensor output voltage is low, meaning a high O_2 level in the exhaust (= mixture too lean = AFR too high = $\lambda>1$), the 'king' signals the ECU. The ECU then responds by increasing the injector 'ON' time, thus admitting more fuel to decrease the AFR.

The sensor now sees a *decrease* in O_2 level in the exhaust, so its output voltage increases (low O_2 = too rich = AFR too low = $\lambda<1$). This sends a signal to the ECU saying 'I'm too rich'. The ECU then responds again by decreasing the injector 'ON' time, admitting less fuel.

This cycle of operation continues indefinitely in closed-loop mode, with the O_2 sensor output constantly swinging above and below the level corresponding to stoichiometry (typically 0.45V), but maintaining this level as its average (Fig.3) — if everything is working as it should.

Of course if the average output from the O_2 sensor remains too low (Fig.4), indicating a high average AFR (i.e., too lean), or too high (Fig.5), indicating a low average AFR (i.e., too rich), there's a problem in the system.

How rapidly does the sensor output voltage swing up and down, or 'switch', when the system is operating normally in closed-loop mode? Generally about eight to 10 times in 10 - 15 seconds.

Sensor problems

Oxygen sensors do burn up — generally when the engine has been operated in the 'too lean' condition for some time. But more often they become contaminated by carbon or residue in the exhaust. An engine which is burning oil will also 'foul' the sensor.

Often 'slow' or 'lazy' switching in closed-loop mode may be corrected by temporarily operating the engine in a lean condition at high idle. This cleans the sensor, as well as the spark plugs.

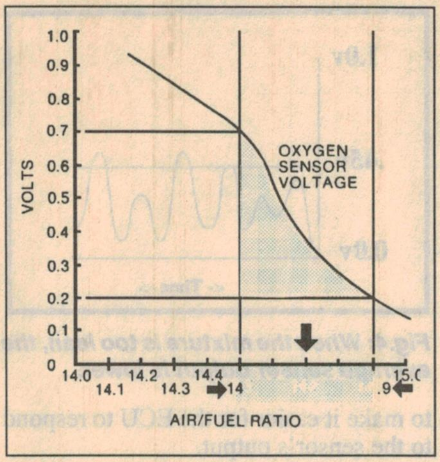


Fig.7: The sensor output should normally be between 0.2V and 0.7V.

The real goal

OK then, we know that if all systems are go and we're in closed-loop mode, we obtain better fuel economy and maintain pollution control. But how do we actually *achieve* pollution control? I thought you'd never ask.

In our quest to achieve the theoretical 'perfect' AFR of 14.7:1, for better fuel economy, we effectively 'open a window'. This window is the best operating area for our three-way catalytic converter ('three-way' refers to the three gases, NOx or nitrous oxides, CO or carbon monoxide, and HC or hydrocarbons).

The graph of Fig.6 shows the idea. This plots the catalytic converter's efficiency, in conversion of each of the three pollution gases, for different AFR levels. As you can see, the little 'window' area at an AFR of 14.7:1 corresponds to the best operating area for the converter — its overall efficiency at converting the three gases can be as high as 98%.

So the stoichimetric AFR of 14.7:1 not only corresponds to peak engine efficiency and minimum fuel consumption, but also to minimum emission of pollution gases — because the catalytic converter is designed that way.

Note that the range of AFR to satisfy these requirements is fairly narrow — the grey vertical band represents an AFR range only 0.1 wide, centred on 14.7:1.

Ideal operation

If we maintain our vehicle correctly, we should be operating with an O_2 output voltage swinging between 0.2V and 0.7V. This corresponds to an AFR between 14.5 and 14.9 in closed-loop operation, as shown in Fig.7. (The ECU must be able to control to 0.05%, which it will — but all systems must be 'go'.)

Here's a good trick. Find a vehicle fitted with an O_2 sensor that's in good nick. Set it up in closed-loop mode — at idle if it has a heated sensor, or otherwise by running it at a constant 1800rpm. Then put your hand on the bonnet and feel the closed-loop AFR control working. On some vehicles, you can hear them 'purring' like a kitten...

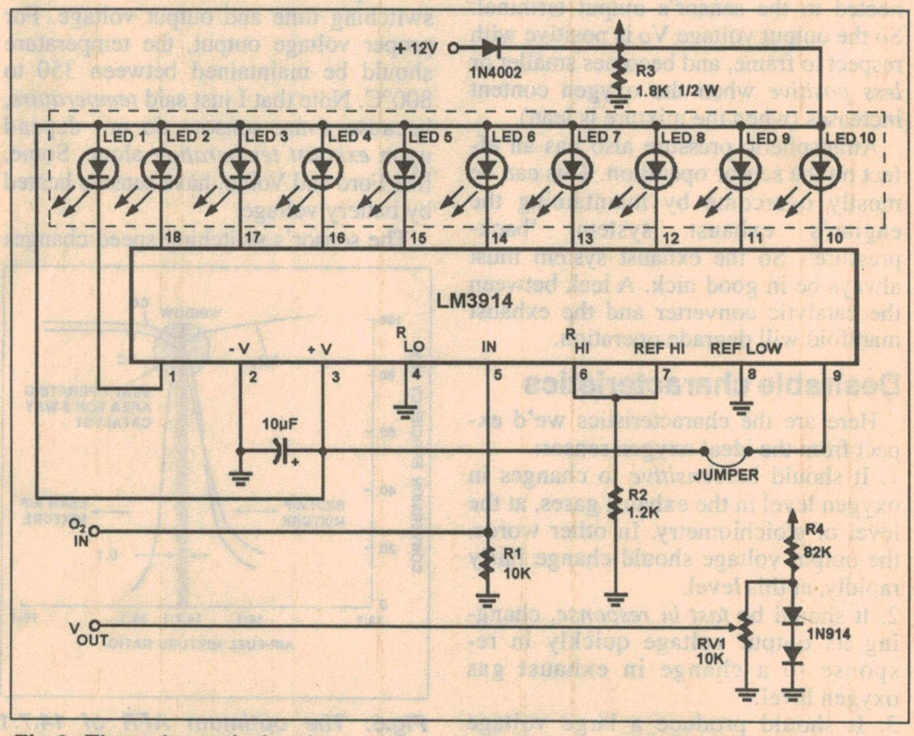
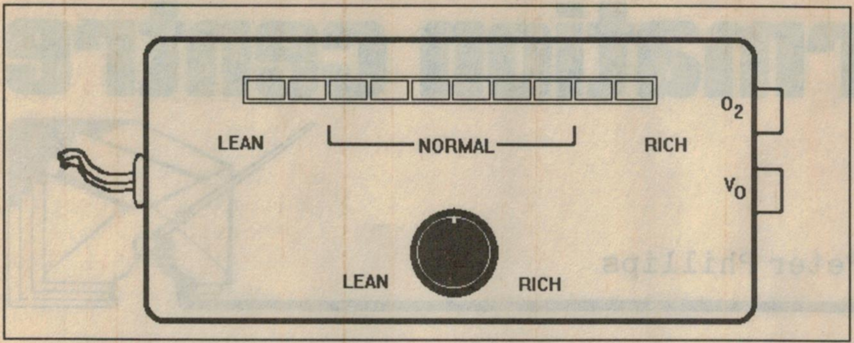


Fig.8: The schematic for the oxygen sensor tester, which is built around a low cost LM3914 'LED dot/bar linear display driver'. It also supplies 0-1.2V DC.



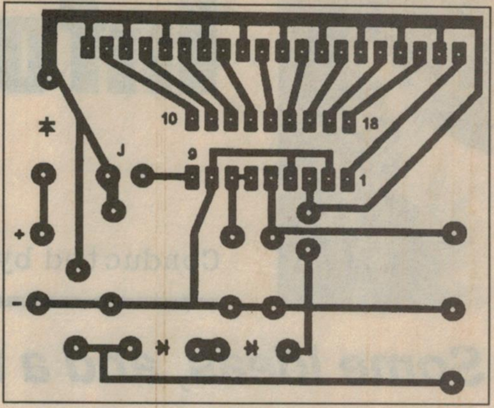


Fig.9 (above): The front panel layout for the oxygen sensor tester. At right is the author's artwork for the PCB, shown here actual size to allow tracing.

Testing the sensor

From the information already given, you might have guessed that all we need to test the O_2 is a DMM (digital multimeter), or similar high impedance (10M ohms) voltmeter. And you'd be right.

On most cars fitted with an O_2 sensor, there are provisions for testing it. Often it's a spade lug with a green wire, near the diagnostic connector and the ECU. But if this kind of test point is not provided, just intercept the lead going from the sensor to the ECU, under the bonnet.

It's also very handy to have a dedicated device to monitor the sensor. After all, it's often a nuisance to tie up your DMM just to monitor the sensor's operation. A low-cost dedicated device can even be mounted in your car, to let you watch the AFR control system at work while you're cruising. That's why commercial testers have been produced.

A mate of mine purchased one of these commercial O_2 sensor monitors from the UK, for A$380.00. Then I told him he could buy all the parts for less than $25, at one of the electronic stores on York Street. Understandably, his reaction was to ask why the @#$%*@ magazines like *Electronics Australia* hadn't shown everyone how to build one! So, let's see how to build an O_2 sensor tester.

The tester

Although a digital readout will let you monitor the sensor's output voltage, an 'analog' type display is much easier to read because the voltage varies so much.

This kind of analog 'bar graph' display can be produced very easily using a readily available and low-cost IC, the Motorola LM3914 — described in the catalogs as a 'LED dot/bar linear display driver'. It's been written-up many, many times, we'll pass on the full description of the way it works (Fig.8).

Basically it responds to a DC voltage fed into its input pin (5), and turns on the LEDs connected to it according to the size of the input voltage. You can have it produce a 'moving dot' type display, where only one LED is on at a time, by leaving pin 9 floating (disconnected), or instead produce a 'varying length bar' display by linking this pin to the positive supply voltage. The choice is yours, and I've allowed for this with a wire 'jumper' link (J), on the PCB pattern.

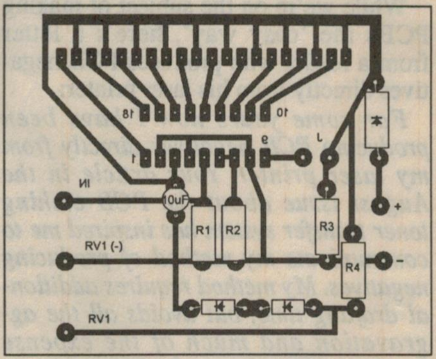


Fig.10: The PCB wiring diagram. The LEDs go along the top, with the IC below.

The best type of LED array for this little project can be purchased from Jaycar Electronics (catalog number ZD-1701). I built one prototype using a piece of 'Veroboard', but as you can see I've produced a PCB pattern to make it easier for you to make one of your own.

Either way, the board is mounted in a 110 x 30 x 60mm plastic utility box, with the LED array mounted in a slot so the LEDs are protected from knocks, but can still be seen (Fig.9). This involved a fair bit of careful drilling and filing — if your box is one of those made from blue plastic, like mine, take special care. This stuff is *really* soft!

Ideally the slot is cut so that the LED array is a fairly tight fit. However if it turns out a bit loose, you can always glue it in place from the inside.

As you can see from the circuit, this tester is actually a dual-function device. The LED readout section can monitor the output from the O_2 sensor, but there's also a simple arrangement of an 82k resistor, two 1N914 silicon diodes and a 10k pot, which is used to provide a stable but adjustable DC voltage between 0V and +1.2V. Labelled 'Vo', this voltage can be used to check the LED display section, simply by connecting it to the O_2 input. It can also be used to substitute for the O_2 sensor in a car, to check the operation of the ECU and the rest of the AFR control circuit.

The construction of the tester is quite straightforward. I have provided the overlay diagram as well as the PCB pattern, to show where everything goes. The power leads should be well insulated and have large clips (clearly marked '+' and '-') to attach to the battery terminals.

For use as a general testing tool, I leave the link J out, so that the LEDs show a 'moving dot' display. However I have also made the same circuit up with the link fitted, so it provides a 'bar graph' display, and mounted it in the instrument panel (dashboard).

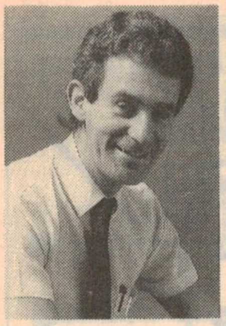
If the LM3914 (which controls the LEDs in a 'linear' manner, with respect to the input voltage) is not available, the LM3815 device (which has a 'logarithmic' curve instead) will also work. On a scale of zero to 1.2 volts, you will not see any difference.

I hope you find this tester useful. ❖

LATE NEWS:

By sheer coincidence, another design for a low cost O_2 sensor tester arrived at our office at almost the same time as this one from Al Younger. We'll try to publish this design in our next issue, because it takes a slightly different approach and will no doubt also have great appeal for readers involved in auto servicing...

Readers intending to make Al Younger's tester should also be happy to learn that Bob Barnes, of local PCB manufacturer RCS Radio, has produced his own very neat version of the PCB. (Thanks, Bob!) Measuring only 62 x 47mm, it fits inside the smallest standard 'Jiffy' box and will take either separate LEDs or a linear array. Coded 94AT1 (RCS number 2428), it is priced at only $5.00 plus $2.20 packing and postage anywhere in Australia. RCS is at 651 Forest Road, Bexley 2207; phone (02) 587 3491, or fax 587 5385.



Information centre

Conducted by Peter Phillips

Some ideas, and a few pleas for help

It's a 'reader driven' column this month. There's some ideas on making PCB negatives, discussion on a 'telephone ring' simulator and a few letters asking for help. I've included the names and addresses of those seeking help, in case other readers can assist where we don't have the answers.

Last month I presented a reader's technique for transferring the track pattern of a PCB directly from a photocopy of the artwork to the copper side of the PCB laminate. You might remember he used his barbecue to heat a lump of steel, which served as the heat and pressure source to do the transfer.

I promised I'd describe any further experiments that readers might have carried out. While I haven't received any comments yet (which is scarcely surprising, as I'm writing this before the December issue even hits the streets), I *have* done some experimenting of my own. In short, while the technique works, I've found that it's not quite so straightforward as our correspondent suggests. Admittedly, I experimented with a relatively complex board pattern, with tracks between IC pads and so on.

My experimenting concludes that the best results are obtained from a direct printout from a laser printer using glossy coated paper. This paper doesn't absorb the toner as much as the usual photocopy paper, and therefore is better suited to 'sharing' with another surface. Conventional photocopy paper, either direct from a laser printer or a photocopier, has a much greater likelihood of giving broken tracks.

It's most important to use the heavy block of steel to get an even pressure that also equally distributes the heat. Temperature is important, and I found 160°C to give reasonable results. Anything over 200°C will cause delamination of the PCB, although the transfer is better. So while the method has potential, it still needs refining.

I'm planning to build a heated press, where one block is heated to say 120°C and the other to 160°C. Being able to get the relatively high, and equally distributed pressure seems to be crucial to the process and a mechanical press should help considerably.

While we're on the subject of making PCBs the 'easy way', here's a letter from a reader who produces PCB negatives directly from his laser printer:

For some years now I have been producing PCB negatives directly from my laser printer. Your article in the August issue about the PCB etching toner transfer system has inspired me to communicate my method of producing negatives. My method requires additional drafting time, but avoids all the aggravation and much of the expense involved with other methods.

I'm not aware of anybody else using this method apart from my immediate associates, who have regarded the concept as something of a revelation (if I say so myself). My method is:

***Step 1.** Draw the PCB pattern with your usual PCB design package (Autotrax, Easytrax, etc.). We'll call this the positive layer.*

***Step 2.** Draw the negative. To do this, move to another layer, which we'll call the negative layer. Using a suitable track width, draw a track right down the centre of the gaps between the tracks on the positive layer.*

Proceed in this way till every track on the positive layer is completely fenced in by the track drawn on the negative layer. What you have just drawn is a layout representing the gaps between the tracks. And surprise, surprise, it didn't take nearly as long to draw as you had supposed.

The width of the track/gap is selected according to the circuit requirements and the desire to minimise on chemical consumption when etching. For instance, low frequency PCBs will work quite happily with a gap between tracks of 0.05mm.

***Step 3.** Position the pad holes. On the positive layer, the holes in the pads are automatically placed by the program, but the holes need to be positioned manually on the negative layer. Do this with a text editor by placing a full stop at every hole centre. A trifle tedious, but with practice you'll rip through this in no time.*

Accuracy freaks will note that on the Protel family of PCB CAD software, the full stop is actually a small square with its bottom left hand corner centred at the position you nominate. That is, the full stop lies slightly above and to the right of where you thought it should be. All you do is move the full stop character to compensate.

***Step 4.** Load a piece of drafting film into the laser printer and print the negative layer. Hey presto, a beautiful negative emerges. Critics might think that drafting film is not transparent enough to be used as a negative, but you'll find the exposure time for it compared to photographic film is virtually the same.*

The limitation with drawing film is that can only be passed through a laser printer two or maybe three times, if you want to print more than one layout on the same piece of paper. The paper tends to buckle after a few passes and the image loses its accuracy.

I don't for one moment suggest that this method is suitable for complex layouts. However, it has served me well for quite a few designs, including digital automotive competition rev counters which involve fast risetime signals.

The extra time used in drawing the negative is repaid many times in not having to go through the usual photographic process. Lateral thinkers

might even be able to do without drawing the positive. A negative produced this way will survive quite a lot of abuse, but best of all, it's all stored on a floppy disk if you need another one, perhaps with a few edits. (Ron Jacobs, East Oakleigh Vic).

Thanks for the idea, Ron. I've often wondered why Protel didn't include a 'negative' facility in their print program, as these days it's easy to produce a suitable photographic master directly from a laser printer on drawing film or on transparency film.

A method I've used myself is to first print the positive design on white paper, scan it, then use the scanning software to obtain a reversal (black to white and vice versa).

After the usual touching up, print out the image to get the negative. Because the scanning process breaks everything into pixels, you lose the smooth curves and get 'staircases' instead. However for simple PCBs, I've found it works quite well.

So there's a few ideas to help get rid of the photochemical processes that make producing a prototype PCB such a complex business. Professionals are probably throwing their hands up in horror by this stage, and I'm the first to admit that we have a way to go before photochemicals can be completely dispensed with.

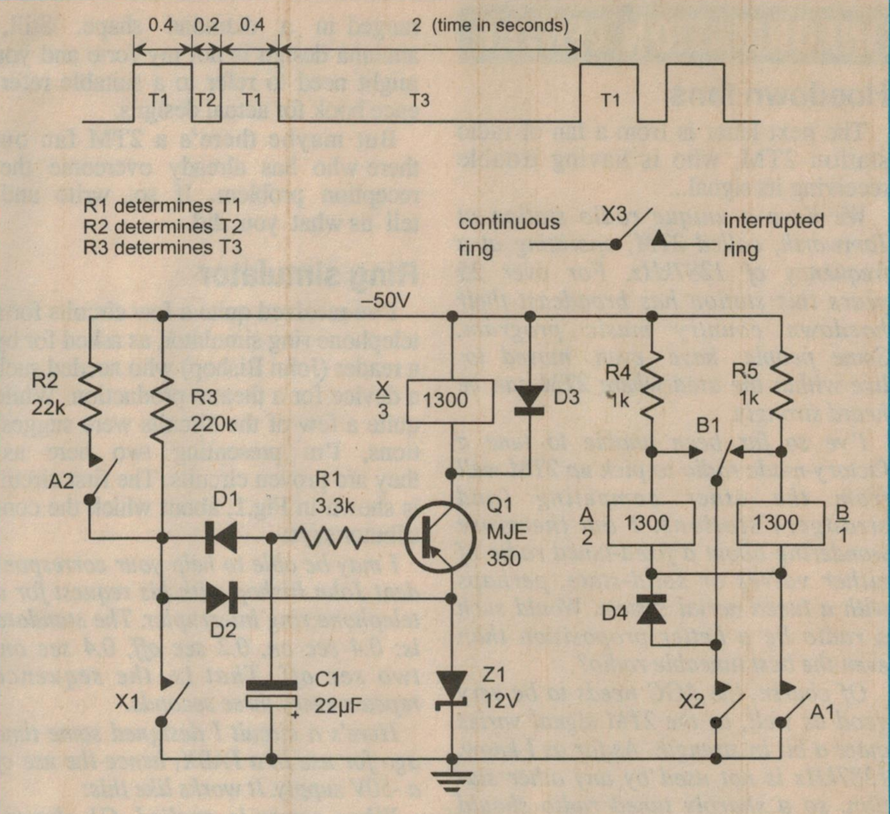


Fig.1

Circuit cellar

You might remember the discussion in September '93 in which a reader sought advice on devices to read brainwaves and the like. I had many responses from readers, with quite a few describing the HAL-4 (Hemispheric Activation Level Detector), a project presented in *Ciarcia's Circuit Cellar Volume VII*, published by McGraw-Hill.

However it seemed this very popular project was only available from the US. But not so! If you are interested in this (and other Circuit Cellar projects), you can buy them from Cebus Australia, who are the Australian dealers for Circuit Cellar. Their address is PO Box 178 Greensborough Victoria 3088; phone number (03) 467 7194, or fax on (03) 467 8422.

TV signal strength meter

As any antenna installer will tell you, a decent TV signal strength meter costs around $800 or more. For this, you usually get a bargraph display for the readout, with facilities to observe the relative strength of each TV transmission. Some instruments have a spectrum analyser type display, to show all TV transmissions at the same time.

These instruments make it quite easy to find the best antenna location and orientation, but at a price. A regular correspondent to these columns might have another, cheaper solution...

Most of us, particularly those living in the sticks, could use a TV signal strength meter from time to time. The traditional way of one person on the roof and another (usually non-technical) next to the TV set communicating with incomprehensible yells based on an assessment of picture quality is generally far from satisfactory. A portable TV set on the roof is a vast improvement, particularly for UHF antenna location.

The cost of a professional meter is not warranted for us non-professionals, and we are generally loathe to co-opt the assistance of the local 'expert'.

But I wonder if a suitable signal strength meter could be made from an old VCR. The tuner section selects each station and a meter could be connected to the video output of the VCR. For instance, a high impedance multimeter connected via a filter and diode could surely serve as a suitable indicator.

If automatic gain control swamps the relationship between input and output signal strengths, the input signal could be tapped so only a fraction of the antenna signal reaches the VCR. Once the video signal has been converted to an equivalent DC voltage, a capacitor across the meter terminals could integrate the voltage.

Perhaps you might consider this as a possible project. (R.V., St Georges Basin NSW).

Thanks for this idea R.V., it's one I certainly hadn't thought of it. And of course a VCR does have the essential requirements for a signal strength meter. That is, a VHF\UHF tuner and an IF amplifier/detector stage connected to a video buffer stage that supplies an output terminal.

However I'm not sure whether this arrangement will work in practice. From memory, most signal strength meters use the AGC voltage as an indication of the relative field strength.

The higher the AGC voltage the higher the signal strength. Of course, once the input signal is below the operating range of the AGC, the output from the video detector is then proportional to the input. But I suspect noise will then tend to mask the signal, giving misleading results at the output.

Still, it would be an interesting thing to try. If any reader has done some experiments using a VCR as a signal strength meter, let me know and I'll include your findings in the column.

INFORMATION CENTRE

Hoedown fans

The next letter is from a fan of radio station 2TM, who is having trouble receiving its signal...

We have a unique radio station at Tamworth, called 2TM, operating at a frequency of 1287kHz. For over 25 years this station has broadcast their hoedown country music program. Some people have even moved to live within the area where 2TM can be heard strongly.

I've so far been unable to tune a factory-made radio to pick up 2TM well from the other competing (and stronger) stations. I am therefore wondering about a fixed-tuned radio of either valves or solid-state, perhaps with a tuned aerial system. Would such a radio be a better proposition than even the best tuneable radio?

Of course, the AGC needs to be very good as well, as the 2TM signal varies quite a bit in strength. As far as I know, 1287kHz is not used by any other station, so a sharply tuned radio should solve the problem. What do you think? (J.M., Windale NSW).

The earliest radio designs were called TRF sets, for tuned radio frequency, where each stage was separately tuned to the desired station. This meant the listener had to juggle several tuning dials to receive a station, making this system impractical as more radio stations joined the fray. However, for a single radio station, a TRF set is probably the best way to go. The idea is simple — each RF stage is tuned to, in this case, 1287kHz. You'll probably find two stages will be enough, perhaps extended to three if the gain is still a bit low.

As far as a design is concerned, we certainly haven't developed anything recently that would suit. However, anyone with a knowledge of radio could probably cobble together a TRF set. I'd suggest using the IF stage of an old valve or transistor radio, but retuned to 1287kHz (from its usual 455kHz). You'd need to either couple the antenna directly to the first TRF stage, or perhaps rework the oscillator/mixer section to give added selectivity and gain — but now working as a simple RF amplifier.

There are ways of tuning the antenna system, but because of the low frequency of the transmission it's not quite that easy. For example, a simple half-wave antenna becomes impossibly long. A design I seem to recall as suiting AM frequencies is the *rhombic* antenna, which has four legs arranged in a diamond shape. Still, antenna design is not my forte and you might need to refer to a suitable reference book for actual designs.

But maybe there's a 2TM fan out there who has already overcome the reception problem. If so, write and tell us what you did.

Ring simulator

I've received quite a few circuits for a telephone ring simulator, as asked for by a reader (John Bishop) who needed such a device for a theatre production. While quite a few of the circuits were suggestions, I'm presenting two here as they are proven circuits. The first circuit is shown in Fig.1, about which the contributor says:

I may be able to help your correspondent John Bishop with his request for a telephone ring interrupter. The standard is: 0.4 sec on, 0.2 sec off, 0.4 sec on, two sec off. That is, the sequence repeats every three seconds.

Here's a circuit I designed some time ago for use in a PABX, hence the use of a -50V supply. It works like this:

When power is applied, C1 charges via R3 and D1. When the voltage across C1 reaches the zener voltage of Z1 (takes about two seconds), base current flows in Q1 which conducts and operates relay X. Contact X1 closes and shunts away the charging current to C1. X1 also provides a discharge path for C1 via R1, Q1 and D2. When C1 is discharged (takes about 0.4 secs), relay X releases and the cycle starts again.

Every time X goes through its operate and release cycle, the bistable consisting of relays A and B changes states and so for every second cycle, contact A2 places R2 in parallel with R3 to reduce the charging time for C1 to a tenth of its previous value. Thus the time that relay X is released is alternately short and long — nominally 0.2 sec and two secs. Contact X3 applies the AC ring voltage to the phone.

These days one could do the same thing with a 555 timer clocking a D flipflop whose output changes the timing components of the 555. However I prefer the relay version as it's more 'macho' and virtually indestructible. (G.L., Ringwood Vic).

Thanks G.L., it's a simple, yet as you say almost indestructible circuit based around three relays.

The next circuit, shown in Fig.2, is even simpler as it doesn't use a transistor. However it does need 3000-type relays with two windings. Still it's a clever circuit, and I've included it specially for those who like relay circuits (like me). Here's how it works...

Concerning the ring simulator, readers might be interested in an approach used around 1948 (no transistors then!), for use in a small PABX. It uses a pair of 3000-type relays wired as shown in Fig.2.

PA is a self-interrupter, with capacitor C1 providing operate and release delays. The operate delay occurs because when PA's contacts close, C1 is (nearly) discharged, so that windings a-b and e-d are both energised (a-b by the capacitor charging current and e-d directly). Since the windings are connected in opposite sense, there is little

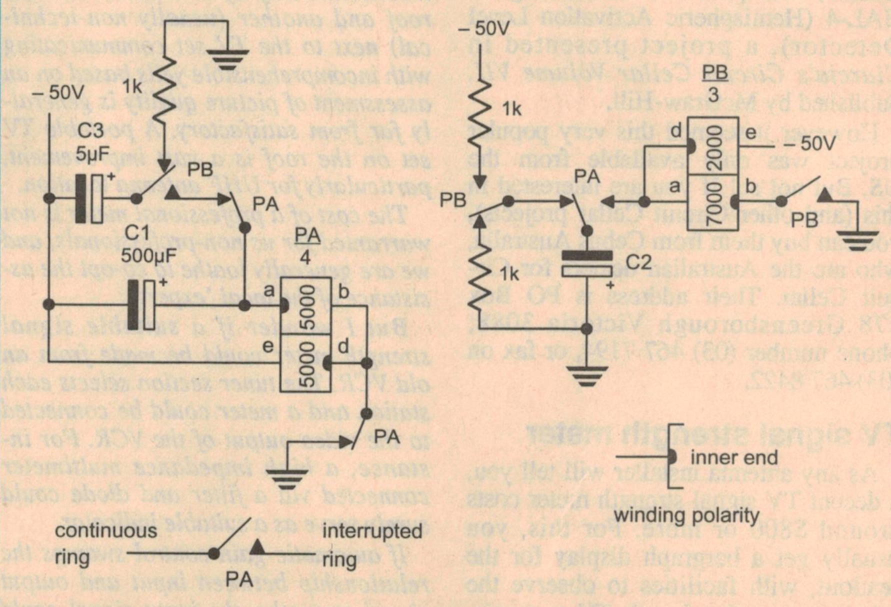


Fig.2

flux generated in the relay until the capacitor current dies away. Then e-d takes control and PA operates.

Now C1 can discharge, through both windings in series, and now aiding each other. Because of the greater number of effective turns, the relay holds on longer than the operate delay before releasing to restart the timing cycle. By itself, PA pulses with a cycle of 0.4s ON/0.2s OFF. PB is used as a binary counter. Whenever PA is released, C2 is charged or discharged according to the present state of PB. When PA operates with PB at normal, C2 charges through PBe-d. PB operates before the charging current dies away, then holds through both windings in series. Note that although they are connected in opposition, e-d has sufficiently more turns than a-b for safe holding.

The next operation of PA puts a charged C2 to PB. Winding d-e momentarily has no voltage across it, but a-b has 50V. The prospective winding ampere-turns is reversed and the relay flux attempts to follow. As it passes through zero, the relay releases and stays so because it has opened its own holding circuit. PB is thus operated or released on alternate operations of PA.

There are PA and PB contacts which discharge an auxiliary capacitor C3, then connect it to increase PA's operate delay from 0.2s to 2s, thus achieving the desired ring interruption cycle.

The generator to produce the 17Hz ringing current used with the circuit was an AWA car radio vibrator, modified by weighting the armature to give 17Hz instead of the usual 50Hz. It had the usual coil and contact, self-interrupting buzzer drive with auxiliary contact which alternately energised either half of a transformer primary winding, from 50V. A suitable secondary and some filtering produced a rough but adequate approximation of a 110V sine wave. (G.W., Florey ACT).

I can remember the days when relays reigned supreme, in both automatic machinery and in telephone exchanges. Rugged and visual in operation, they clacked away relentlessly. Of course the main problem was dirty contacts, but with regular maintenance, relays seemed to be able to work forever.

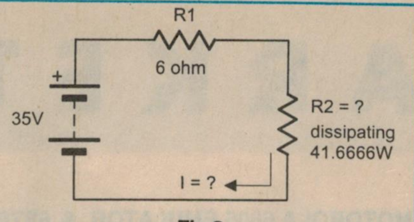


Fig.3

So thanks, G.W., for sending me this 'relay only' circuit. I doubt a solid-state circuit would have so few bits, and be able to directly operate the bell at the same time.

C64 offer

Here's an offer from a reader with a special interest in the Commodore 64 computer:

In the August edition you included a letter from P.C. of Candelo, NSW who asked for projects for the C64 computer. When I first got my C64, no one seemed to do anything except produce games, which is not what I wanted.

However over time I've been able to gather all sorts of functional but free programs. I am willing to pass on these programs to readers for the cost of a disk, $2 for copying and $3 postage. Interested readers can write to Bruce Evetts, 208 James Street, Whakatane, New Zealand.

Thanks, Bruce, for this kind offer. I'm sure quite a few readers will be interested.

Model train problem

It's not often I get letters asking for advice about model trains...

My query concerns reverse loops in a table size model train layout I am constructing for my children. To simplify control operations, I am wondering if there is some reliable electrical way (that is not too expensive) to sense the position of the driving engine at a particular point on individual pieces of track, for train/current direction purposes. Micro switches controlling relays have been suggested, but the underneath of each engine is sufficiently different to make this difficult and probably unreliable. Micro switches through the rails don't appear to be practical either.

Current sensing with a time delay was another suggestion, but this would have a problem coping with varying train speeds. I'm a fan of the KISS rule, but I can't see a simple solution. Can you or your readers help? (Neale Adams, 47 Pine Street, Hamilton Qld 4007).

Not being an enthusiast of this hobby, I can't draw on practical experience. Things like optical interrupters, ultrasonic position indicators or Hall effect devices come to mind as a means of detecting the presence of a train. I also remember seeing a system that detected a train by the additional weight on the track. However, this is likely to be one of those problems solved many times already by model train enthusiasts. If anyone can help, either write to the magazine or perhaps direct to Neale Adams.

Exhaust gas analyser

The next letter is also one we can't help with, but it's possible a supplier or a reader might just have the answer.

I'm enquiring about exhaust gas analysers. Have you ever published information on these, or produced a project that uses such a device? There appears to be no commercially available analyser of this type. The closest thing is a very expensive carbon monoxide and hydrocarbon analyser. (Gavin Lewis, PO Box 253, Emerald Vic 3782).

We haven't designed a recent project around such a device, as they are not readily available. As well, we haven't run an article about exhaust gas analysers. However, such devices must exist, as they are used in analysers found in most garages. If anyone can help Gavin, perhaps you might contact him.

And here's another request from a reader...

UV sensor

We want to build an ultraviolet UV-A, UV-B/C instrument. Do you have such a project in the pipeline?

Alternately, do you know of any suppliers of UV sensors, or do you have any other suggestions? (Graham Guttridge, School of Applied Science, Canberra Institute of Technology, PO Box 826 Canberra ACT 2601).

I believe UV sensors are available, though not readily. One possible source is Zeta Electronics, of PO Box 342, Drummoyne 2047: phone (02) 81 4805.

Continued on page 129

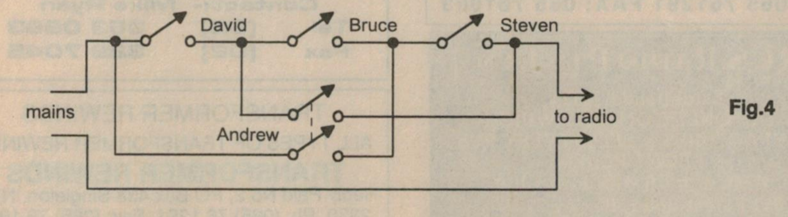


Fig.4

EA MARKETPLACE

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EA MARKETPLACE

INFORMATION CENTRE

Continued from page 127

When last we heard from them, this firm was selling a locally-made UV meter: the Heliometer. At present the magazine is not planning to present a UV measuring instrument as a project. So again, can anyoneout there help our reader?

M208B IC

And here's another plea for help...

I am writing as a last resort to track down the main IC used in the Stroboscope Mk2 project described in EA for May 1992. The IC is listed as a type M208B and described as a synthesiser IC. Unfortunately, no one seems to have heard of it and none of the major parts suppliers have this project as a kit. I can probably get all the other bits, but I wonder if you or a reader can help me track down an M208B. (Irwin Brenner, 42 Walmsley Drive, Noranda WA 6062).

My usual suggestion in cases like this is to contact your local Radio Spares or Farnell agent. These companies generally have a large range of hard to get ICs, although I must admit I can't find the M208B listed in the Farnell catalog. Perhaps a supplier (or reader) can help, Irwin. The chip concerned was made by the Italian firm SGS-Ates, and described as a 'one chip organ'.

What??

Resistive network problems are usually popular, and I'm able to present just such a problem sent to me by Bryan Maher (Mermaid Beach, Qld). Readers will no doubt know of Bryan through his many writings for this and other magazines. The question is:

In the circuit of Fig.3, a 35V battery is connected to two resistors in series. We know that R1 has a resistance of 6 ohms. Unfortunately, we don't know the value of R2, except that it is dissipating 125/3 watts (41-2/3 watts) of power. Find the current flowing in the circuit and the value of R2.

Answer to December's What??

The solution is shown in Fig.4. The switches owned by David, Bruce and Steven are in series. Close all three and power is supplied to the radio, regardless of the position of Andrew's switch.

If Andrew's switch is closed, closing any one of the other three switches connects power to the radio. Trace it out, if you're not sure! My thanks to Barry Duncan (Rockdale NSW) for the solution. ❖

50 and 25 years ago...

'Electronics Australia' is one of the longest running technical publications in the world. We started as 'Wireless Weekly' in August 1922 and became 'Radio and Hobbies in Australia' in April 1939. The title was changed to 'Radio, Television and Hobbies' in February 1955 and finally, to 'Electronics Australia' in April 1965. Below we feature some items from past issues.

January 1944

Super bomber: America's new B-29 super-bomber will soon have its final test. The plane is said to have a range of more than 10,000 miles and a bomb capacity of at least nine tons. It can fly at very high altitudes and is heavily armed.

Sikorsky helicopter: By designing a simple helicopter which can rise or come down vertically, the American Igor Sikorsky has solved a problem which has engaged the attention of aircraft designers for many years.

The design has a main rotor which whirls round at about 300rpm, and the control of lift is effected by altering the rotor pitch. This is achieved by moving the pilot's combined throttle and pitch-control lever. Once the desired altitude is reached, the rotor is tilted slightly in the direction in which the machine is to travel. If the engine fails in flight, the machine descends slowly because the rotor blades, disengaged from the power unit by a clutch, continue to spin and provide enough lift to prevent a crash.

January 1969

Computers for Vic colleges: International Computers is to participate in one of the largest developments in computer education in technical institutes in Australia. The Victorian Institute of Colleges has ordered six 1900-Series computers worth more than $1,800,000.

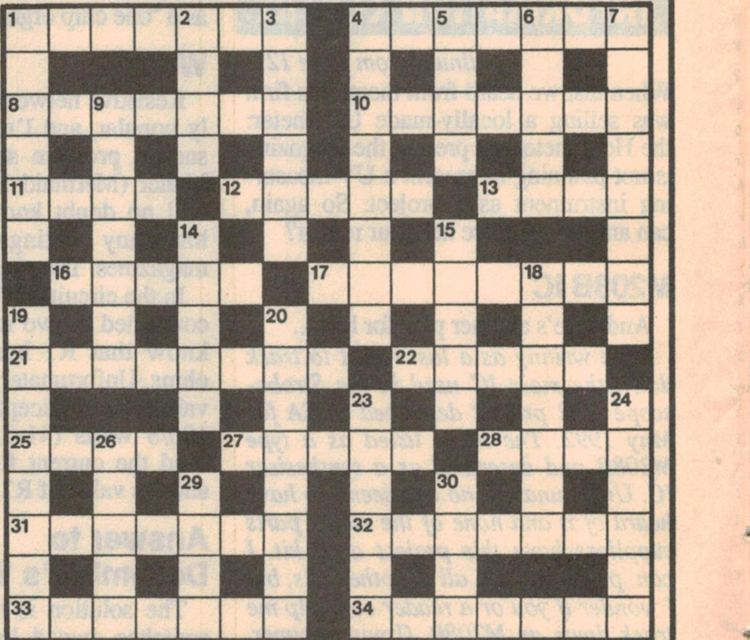
The computers will be used mainly for teaching computer techniques, but will also be used for some research and for college administration. Already some 6000 students at the colleges receive computer training and this number is expected to increase to about 14,000 by 1972.

Datel modems: Standard Telephones and Cables (UK) is supplying nearly 10,000 modems (modulator-demodulator units) for the British General Post Office's 'Datel 2400' system. This is a public data transmission system to be operated by the GPO, capable of dealing with 2400 binary bits a second in the form of tone signals. The modem converts the digital information into the tone signals for transmission over landlines.

Laser aids tunnel work: The Tasmanian Hydro Electricity Commission is using laser beams to align tunnels in the 14,000ft Wilmot diversion of the Mersey-Forth development. In good conditions the laser could be used for distances up to 4000ft and required shifting only three times during the construction of the whole Wilmot tunnel.

A laser beam was also used in the construction of the Pindari Dam, to gauge the placing of loads on the wall face. Using the laser beam as a plane of reflex, operators working on the dam walls were able to place the fine rock of the upstream wall with high accuracy, thus saving both time and concrete in the after-trimming of the wall face. ❖

EA CROSSWORD



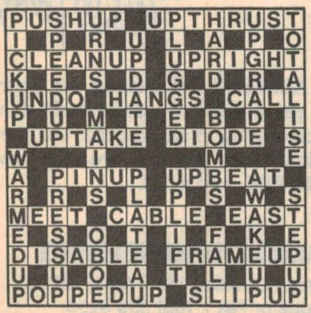
ACROSS

1. Satellite-launching facility in Florida, the —— Space Centre. (7)
4. Nature of a wire in AC circuit. (7)
8. Said of certain computer operations. (7)
10. Supposed being causing trouble. (7)
11. Radio engineers' association. (1,1,1,1)
12. Possibly said of one repetitively sending 's' in Morse. (5)
13. Vertical take-off acronym. (4)
16. Brand of light globe. (5)
17. Industry in which 10 across originated. (8)
21. Product of battery charging. (8)
22. Well-known surname in electronics retailing. (5)
25. Type of connector. (4)
27. Information tables. (5)
28. Home of BBC World Service, —— House. (4)
31. Increases by a certain factor. (7)
32. One engaged in systematic study. (7)
33. Fail to reproduce a signal accurately. (7)
34. Type of radar. (7)

DOWN

1. Temperature unit. (6)
2. Act on surface. (4)
3. Colour in the visible spectrum. (6)
4. Such is one pole of a battery. (8)
5. One who operates a computer. (4)
6. Again ignited. (5)
7. Telecommunications cable. (8)
9. Coated with lubricant. (7)
14. Leading brand of copier. (5)
15. Hard radiation, or —— rays. (5)
18. Do this to activate an installed PIR detector. (7)
19. Protected by an external cover. (8)
20. Artificial satellite. (8)
23. Occurred in brief bursts. (7)
24. Less grey. (6)
26. Obsolete unit of magnetic induction. (5)
29. In addition. (4)
30. Transfer computer data to an intermediate store. (4)

SOLUTION FOR DECEMBER 1993



Electronics Australia's

Professional Electronics

S·U·P·P·L·E·M·E·N·T

REVIEWS OF MICROSOFT VISUAL BASIC FOR DOS, HI-TECH SOFTWARE'S CROSS COMPILER FOR C

PROCON UPGRADES ITS HARDWARE & SOFTWARE FOR PC-BASED PLC'S

EXPANDED SECTION FOR NEW PRODUCTS: TOOLS, TEST INSTRUMENTS, ETC

DATAPRODUCTS CORP'S NEW 600DPI LASER PRINTER HAS A DRIVER FOR WINDOWS' GRAPHICAL DESIGN INTERFACE, ENHANCED HALF-TONE SCREENING SYSTEM

NEWS HIGHLIGHTS

CHURCHILL FELLOWSHIP APPLICATIONS INVITED

The Churchill Trust is inviting applications from people of 18 years and over from all walks of life, who wish to be considered for a Churchill Fellowship to undertake during 1995, an overseas study project which will enhance their value to the Australian community. Each year the Trust awards a number of these Fellowships, each valued at around $13,000 and including three months' overseas travel.

No prescribed qualifications are required, merit being the only test — whether based on past achievements or demonstrated ability for future achievment. The Fellowships are not awarded for the purpose of obtaining higher academic or formal qualifications.

Details may be obtained be sending a self-addressed stamped envelope (120 x 240mm) to the Winston Churchill Memorial Trust, 218 Northbourne Avenue, Braddon ACT 2601. Completed application forms and reports from three referees must be submitted by Monday 28th February 1994.

ANU ENGINEER WINS 1993 ATERB MEDAL

The 1993 Outstanding Young Investigator Medal for 1993 has been awarded jointly by the Academy of Technological Sciences and Engineering and the Australia Telecommunications and Electronics Research Board to Dr Rodney A.Kennedy. Dr Kennedy is a remarkable young theoretician who has already made, and is continuing to make unique contributions in the field of telecommunications channel equalisation. Dr Kennedy has a rare combination of applied mathematical skills and engineering understanding.

Dr Kennedy's chosen field of equalisation is becoming increasingly important as telecommunication companies look to maximise their return on the considerable capital invested in infrastructure, and the services demanded are no longer just simple voice telephony but include high speed data and real time video which need broadband channels.

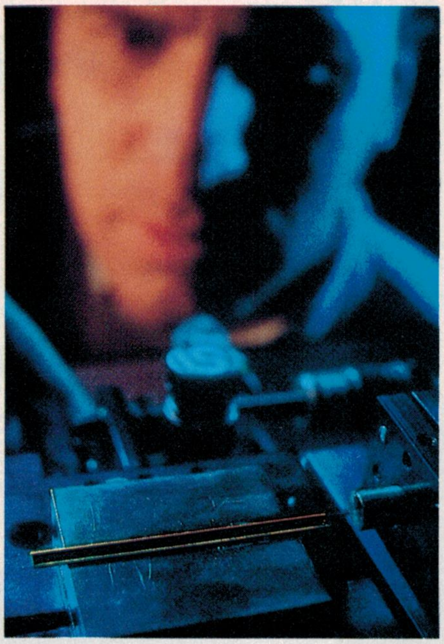
Advanced equalisation techniques are necessary to maximise the capacity of such channels. Dr Kennedy has made fundamental contributions to the understanding of error propagation in decision feedback equalisers and has developed a new theory for the operation of blind adaption equalisers. This latter work may prove important in providing the best performance over the rapidly changing channels now so common in mobile services.

Although now specialising in telecommunications applications, Dr Kennedy has applied his skills to a number of other fields. As a graduate engineer he undertook analysis in such diverse areas as geodesy, antennas and control systems. In the last field Dr Kennedy conceived a new method for digital controller design which was successfully incorporated in the Australian Telescope for CSIRO.

PHOTONICS SUCCESS BY BELL LABS

Researchers at AT&T Bell Laboratories in Murray Hill, New Jersey, have produced optical waveguide amplifiers on silicon wafers, which someday may be useful in optical switching and computing. These optical amplifiers are treated with the rare earth element erbium to boost light signals travelling the waveguides. After an erbium-treated glass film is deposited on a wafer, waveguide structures are formed using standard photolithography techniques. Hundreds of waveguides can be patterned on each wafer, and the waveguides, which can be linked with optical fibres, could connect optical components to one another on the silicon wafer.

Using this technology, AT&T Bell Laboratories researchers Phil Becker, Gerald Nykolak, Joe Shmulovich and Russ Wong, can make optical-waveguide amplifiers that are comparatively easy to mass produce. Currently, the experimental amplifier's net fibre-to-fibre gain is



the highest yet reported for these devices. A 32-fold signal gain is achieved in a waveguide just 45mm in length. Work is continuing to reduce the required laser power to more practical levels.

HIGHEST OUTPUT EXCIMER LASER

Toshiba Corporation in Japan has developed an excimer laser with an output power of 8W. This doubling of typical output is claimed to achieve the highest output of any excimer laser used for lithography, and to represent an important contribution to the process technology for advanced generation of memory chips and other semiconductors.

Forthcoming generations of DRAM chips will require minute patterning to increasingly severe tolerances: 0.35um pitch for 64-megabit devices, and as fine as 0.25um for 256M DRAM.

Working with the precision necessary for this level of design rule requires a light with a very short wavelength. The i-line beam from a mercury lamp widely used in current steppers has a wavelength of 0.365microns. The excimer laser has a much shorter wavelength of just 0.248 microns, making it much more suitable for future generations of equipment.

The highest output of the excimer laser for lithography currently available in the market is 4W, but a higher output is required for the larger wafer and chip size of forthcoming generations of DRAMs. Toshiba researchers have achieved higher output by developing a new type of resonator.

In the current excimer laser system, the light is resonated between mirrors placed

NEW DIGITAL LOGGING RECORDER

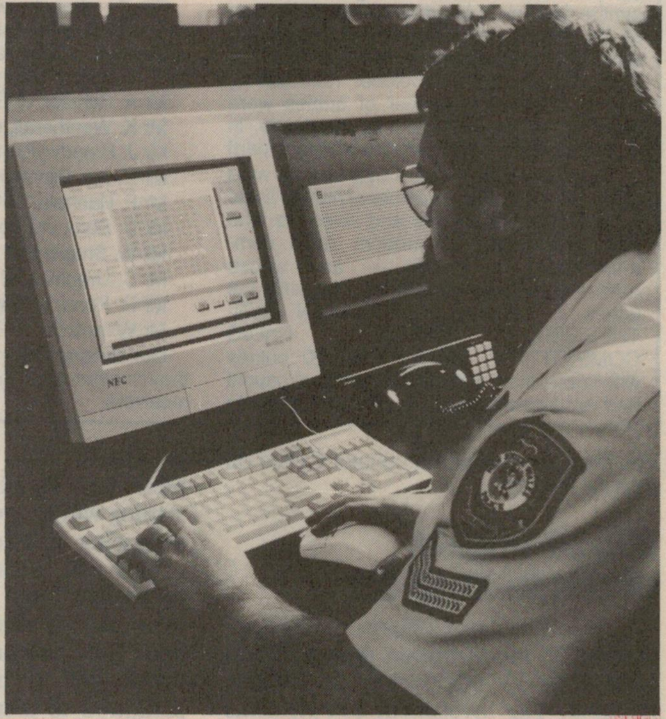
Australian logging recorder manufacturer Electrodata has released its latest logging recorder model, called 'Digitrac', which uses digital technology. Analog logging recorders are presently used by emergency services, airports, TAB's, banks and numerous other organisations where life or money may depend on the integrity of a telephone or radio conversation. Although analog recorders are very cost effective at high channel capacities, it is expected that digital logging recorders will satisfy a market need for convenience at lower channel numbers.

Electrodata's new recorder has outstanding and innovative features, including an ability to retrieve conversations immediately from the very convenient DAT computer back-up tape cassettes used, without the need to disturb the currently recording tape or run two tapes in tandem. The Digitrac is available in eight, 12, 16, 24 and 32 channel models in a compact PC-sized stand alone cabinet, and up to 96 such cabinets may be controlled by a single keyboard and monitor. Thus total channel capacity for a Digitrac network is over 3000 channels.

The Digitrac recorder is built from industry standard components, many of which are available from any computer house. Virtually all hardware related repairs can be effected by swapping boards and software support is performed by Electrodata's engineering team at Mortdale, NSW.

The Digitrac is capable of recording up to 360 channel hours per DAT tape, thus providing as much as 48 hours of coverage on 32 channels of typical telephone conversations, per cabinet. Each cabinet is fitted with two DAT transports and a hard disk, thus providing triple redundancy for recording safety.

The most striking feature of the Digitrac is its user interface. Electrodata has designed the recorder for operation from a colour monitor and full keyboard, rather than opt for LED displays and telephone touch pads which are both user unfriendly and limited in their scope of operation. Thus the Digitrac user is able to manipulate and listen to messages with ease as well as monitor the complete performance of the system.



at either end of a discharge tube until it is amplified to a point where it is strong enough to be output. This design places a mirror at the emission point, where peak output power is reached. When the beam hits this mirror, it loses some of its output power as reflection. Toshiba's newly developed resonator guides a small part of the laser from the discharge tube through a prism, and resonates it between one mirror at the end of the discharge tube and another placed at an angle above the tube. Removing the mirror from the emission point cuts reflection loss and allows output of a full 8W beam. In addition, a 600MHz repetition rate assures stable patterning.

A stepper uses combinations of lenses made from different materials, to prevent chromatic aberration and to realise sharper patterning. However, for light with a wavelength below 300nm, only a synthesised quartz glass can be used as the lens material, and the blurring produced by chromatic aberration is unavoidable when normal excimer lasers are used as a light source in a stepper.

This makes it necessary to further narrow the wavelength, to obtain a monochromatic laser with a spectral linewidth of less than one picometre (pm). Toshiba has achieved this with an etalon element.

Etalon is very expensive, and exposure to the high output of the excimer laser as a narrow band element results in a very short life. In Toshiba's new laser, the laser density at an etalon is one third of that in earlier models, which prolongs the etalon's life by over 10 times.

The new laser equipment has a footprint of just $0.75m^2$, the smallest in this output class. It can be set just beside the stepper to save space in the clean room, and is simple to maintain since its unit parts can all be accessed from one side.

NEW ELECTRONICS TRAINING BODY

At a recent meeting, the Electronic Services Industry Association (ESIA) decided to split its training activities away from the remainder of the Association's functions, because of the huge demand being placed on its resources. Accordingly a new training subsidiary has been set up under the name Electronic Technology Training Corporation (ETTC), which has been registered as a company.

The aims of the ETTC are to provide industry training, either for the ESIA or for in-house training as required by any electrical or electronics organisation. Further information is available from ETTC via Box 154, Carlingford 2118; phone (02) 564 1991 or fax (02) 868 2810.

DATA RECOVERY SERVICE

Melbourne-based firm Cybec, which until now has specialised in anti-virus software, has diversified into data recovery. The company believes that Australians have hitherto been poorly served with data recovery services, with many firms and individuals being either forced to 'rebuild' their data using outdated backup files, or simply write off information as 'lost' when computer disasters occur.

This is not the case in the UK, Europe or the USA, where data recovery is a well established industry.

"Data recovery techniques are now so good that in the majority of cases something, if not all of the data can be recovered. The time saving is huge," said Nick Engelman, Cybec's principal data recovery expert. "We see Australia waking up to this over the next few years, and with Cybec's anti-viral experience, we will be able to offer a unique service."

Prices for the service are \$95 per floppy disk and \$495 for the first megabyte for hard disks, plus \$5 per MB thereafter.

WINNERS OF OUR SANGEAN CONTEST

When Dick Smith Electronics very kindly sent us 10 of their new Sangean ATS 606 synthesised multi-band receivers, to be won by *EA* readers, we decided to run an easy-to-enter 'list the inventors' competition. This ran in the September and October 1993 issues, and a very large number of entries were received — an overwhelming response, in fact. Many thanks to everyone who took part!

The entries also varied over a very wide range, in terms of the number of names listed for scientists, engineers and inventors who have contributed to modem radio communications technology — and whose names could also be formed using only the letters in the words 'SANGEAN SYNTHESIZED WORLD RADIO COMPETITION'. We had over 20 entries with more than 100 names, while a couple had amassed more than 500! Needless to say this didn't make our judges' job any easier, since they all had to be checked...

Finally, though, we have been able to come up with the list of 10 winners, each of whom gets a Sangean ATS 606 receiver. So here are those lucky readers:

Mr A. Schiffer, of Greensborough, Vic.
Mr K. Weatherall, of South Otago, NZ.
Mr J. Brandwyk, of Flagstaff Hill, SA.
Mr E. van Rijnswoud, of Lesmurdie, WA.
Mr P. Hanhela, of Gisborne South, Vic.
Mr B. Saru, of Lae, Papua New Guinea.
Mr W. Shapley, of Glen Osmond, SA.
Mr C. Urquhart, of West Pymble, NSW.
Mr R. Pond, of Dwellingup, WA.
Mr W. Kelson, of Padbury, WA.

Our congratulations to them, and we trust they're already enjoying the use of their new receivers.

For further information contact Cybec on (03) 521 0655.

MAJOR PHILIPS INVESTMENT IN UK

Philips Display Components has announced a multi-million pound investment in its TV tube factory in Durham, England. The investment complements the recently announced decision to adapt part of the production line at Philips' TV tube factory in Lebring, Austria, to manufacture colour monitor tubes.

In the first phase of the Durham expansion plan, scheduled for completion by October 1994, £16 million sterling will be invested in upgrading and expanding facilities.

This will include an initial capacity expansion from two to 2.3 million tubes, the introduction of a new product, and the building of an extension which will include a clean room installation to meet the highest performance requirements.

The Durham factory is Philips' European production centre for medium size flatter and squarer tubes, and the investment program will introduce the 41cm FS tube in addition to the range of 51cm FS tubes currently produced.

Around 35 new jobs will be created during the first phase of the investment program.

The development is being fully supported by the UK Department of Trade and Industry within its program of regional selective assistance.

AUDIO FIRM EXPANDS

Melbourne-based hifi amplifier kit maker Contan Audio is expanding its activities to supply audiophile constructors, hifi dealers and modifiers with high quality components and kits from local and overseas manufacturers.

The main aim is to provide the customers with high quality products at an affordable price, according to its principal Tean Tan.

The best of the local products available include interconnect and speaker cables, output transformers, capacitors and Contan's own Stereo 80 valve amplifiter kit.

The overseas components and kits include the following:

- MIT, Kimber and Solen capacitors, HOLCO and Vishay resistors, WBT connectors, Kimber cables and interconnects, Audio valves and sockets, Alps and other pots.
- Melbourne Lab kits from the USA (valve preamplifier and solid state power amplifiers).

CSA SOLD TO CSC, SIGNS $450M CONTRACT

Australia's AMP Society has sold its systems integration and software development subsidiary Computer Sciences of Australia, to Computer Sciences Corporation (CSC) of the USA. At the same time, CSA and the AMP have signed an outsourcing contract worth $450 million.

Under the outsourcing contract, the largest ever signed in Australia, CSA will provide all of AMP's information technology processing resources and a significant percentage of AMP's software development activities for the next 10 years.

The processing resources will be based in the major data centre at Bondi, which has been acquired by CSA. In addition, CSA will operate AMP's data network which links offices in Hong Kong, New Zealand, the UK and Australia and provide a wide range of information systems and communications services.

A large number of AMP information technology staff have joined CSA following the signing of the outsourcing agreement.

Based in El Segundo in California, CSC employs 26,000 people working from 300 offices principally in the US and Europe. Revenues last year totalled A$3.6 billion.

CSA is Australia's leading systems integration, outsourcing and software development company with annual revenues of $114 million, over 1100 employees and offices throughout Australia and in New Zealand. Major defence contracts include those for the Royal Australian Navy's new Collins Class submarines and the ANZAC ships.

Von Honeycutt, President of Computer Sciences Corporation (left) and Peter Rehn, Managing Director of Computer Sciences of Australia.

- Virtuoso from the UK (valve preamplifier and solid state power amplifiers.

A product catalog is available for $1 by contacting Contan Audio, 37 Wadham Parade, Mt Waverley 3149; phone/fax (03) 807 1263.

QLD MICROWAVE CENTRE PLANNED

Brisbane's first Space Industry Development Centre, the Centre for Microwave Technology is to be established as a joint project by Griffith and Queensland Universities, with the CSIRO as research partner and leading microwave technology company Mitec Ltd as commercial partner.

The Space Industry Development Centre program is a major element of Australia's Integrated National Space Program, which has been developed to redress the lack of commercial space products available from Australian industry. The program will encourage the involvement of Australian companies in space businesses by creating 'centres of excellence' in space-related technologies, such as the new Centre for Microwave Technology.

These centres will be available for use by firms wishing to develop products for domestic and international markets.

For further information on the Centre for Microwave Technology, phone (07) 875 5053.

NEWS BRIEFS

- ***Protel Technology*** has taken over the organisation and management of Protel Software training courses from Zelcon Technic. Such courses qualify as eligible training programs (as defined by the Training Guarantee Act 1990).
- ***Wedgetail Technologies*** has appointed Jeff Davies as its new General Manager. He was previously the National Sales and Marketing Manager of Marconi Instruments. With its head office in Sydney, Wedgetail was set up by its Melbourne-based parent Quantek Group to distribute the test and measurement equipment from Schlumberger Technologies in Munich, Germany and St Etienne, France
- ***Akai***'s Managing Director, Mr James (Atsushi) Asakura, has been appointed to the Board of Directors of the parent company, Akai Electric. He will continue to run the Australian operation.
- Queensland-based ***Palmtech*** has advised that TECS Wholesale of Melbourne can now supply its Toner Transfer System kit for making PCBs. Stocks are available at the 289 Latrobe Street store; phone (03) 602 3499, fax 670 6006.
- The growing area of interactive multimedia will be covered at ***SMPTE '94***, Australia's major conference for film and television. The conference will be staged at Darling Harbour, Sydney from July 5 to 8. For further information phone (02) 977 0888, or fax 977 0336.
- Manufacturers of microwave frequency counters, XL- Microwave of California, has appointed ***Scientific Devices*** as its Australian representative. ❖

TECH SUPPORT VIA COMPUSERVE

Australian communications specialist Banksia Technology has extended an already high level of support by going online to CompuServe Pacific, and introducing an extra year's warranty for its products. The CompuServe service gives Banksia modem users who are also CompuServe Pacific members access to 24-hour technical support nationwide for the cost of a local call. Banksia technical support services on CompuServe will include instant access to software updates and information on how others use Banksia's products to solve their problems. Users can also make inquiries about products and receive replies within 24 hours.

The company has extended its warranty from the industry standard 12 months to two years, for customers who send in their warranty registration cards. "It demonstrates the faith we have in our manufacturing and quality control," says Managing Director, Mr David Stewart.

Banksia's highspeed and pocket modems are manufactured and tested in a high tech surface mount factory at Silverwater, NSW. The plant's TQM accreditation ensures consistent quality — Banksia expects to exceed a 99.5% reliability target.

AUTOMATE & ELENEX CLAIM A RECORD SUCCESS

The combined Automate 93 and Elenex 93 exhibitions, staged at Sydney's Darling Harbour from 31 August — 3 September claim to have achieved a record attendance.

Both events are stages by Australian Exhibition Services (AES), which ahs stages many of Australia's most successful exhibitions. "Both Elenex and Automate have been an outstanding success in Sydney," said Exhibition Director Noel Gray. "9217 visitors is a record attendance, and we were particularly pleased with the high quality of the audience and the number of exhibitors that reported actual sales at the exhibition," he said.

Automate 94 and Elenex 94 will be staged concurrently at Melbourne's Royal Exhibition Building from 18 - 21 October 1994.

DR DICK SMALL MOVES TO THE USA

Speaker designer Richard Small, well known around the world for his pioneering work with Australian engineer Neville Thiele, and in recent years the chief engineer for KEF in Britain, has moved to the USA. Dr Small has accepted the position of Principal Engineer with Harman Motive, part of the Harman Kardon Group, based in Martinsville, Indiana.

Harman Motive is a leading designer and manufacturer of high-end sound equipment for cars, and many of its products are installed as original equipment in America's top of the range vehicles. At Harman Dr Small is expected to be applying the R&D knowledge and insights he gained working in Project Eureka, towards the development of the 'next generation' of car sound systems employing digital signal processing technology. ❖

MICROSOFT'S VISUAL BASIC FOR DOS, V1.0

Visual BASIC for DOS brings many of the advantages of the original *Windows*-based Visual BASIC to the familiar DOS environment. Using it, you can easily create application programs with a very 'friendly' user interface — thanks to the way the language is event-driven and object orientated. The final programs can also run surprisingly fast, because VBDOS comes complete with a compiler which can turn them into free-standing '.EXE' files.

by JIM ROWE

When the original BASIC was developed at Dartmouth College in 1964, it was intended essentially as a simplified language for programming tyros — a learning tool, to be discarded in favour of more 'serious' languages when the user gained more knowledge and experience. This 'toy' image has tended to remain with BASIC over the years, and many 'professional' programmers tend to view it with distain.

Some of the reasons for this poor reputation are quite objective, of course. Most BASICs have been interpreted languages, making the resulting programs fairly slow in execution. Although some compilers have appeared, they have often not been fully compatible with a popular interpreter, causing hassles of their own. Then when the concepts of structured programming evolved, and assumed the status of semi-religious tenets, many versions of BASIC fell further from grace because they didn't enforce this way of doing things.

The funny thing is that despite these shortcomings, there are probably still more programs written in BASIC than in any other language. No doubt that's partly because of the personal computer 'revolution', which in the last 15 years or so has made computers as a tool accessible to scores of millions of people. And a large proportion of those PCs have come complete with a 'free' bundled copy of BASIC, so *it* has been readily available too...

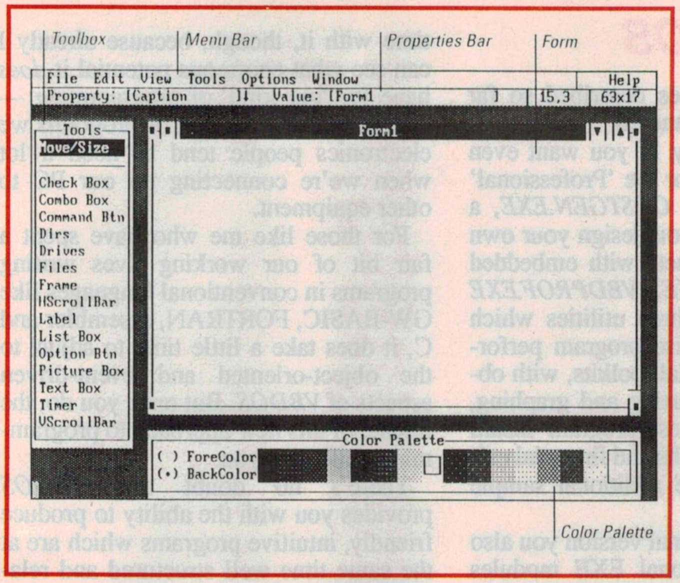
But these are surely not the *only* reasons for BASIC's enduring popularity. The fact is that for a great many 'quick and dirty' programming tasks, where you simply want to knock out a small program to do a specific and fairly simple job, BASIC is perfectly OK — despite what the 'professionals' and the computer science lecturers might say.

There are of course many applications of this very kind in electronics, especially when you're using a PC to monitor and/or control other pieces of equipment. If the equipment can be hooked up to the PC via a standard RS-232C serial or Centronics parallel port, it's often very easy to knock out a simple program in BASIC to put it through its paces — much easier, in fact, than firing up a package to produce an equivalent program in C, Pascal, assembler or whatever. It's generally a lot cheaper, too, especially if you use Microsoft's venerable old GW-BASIC.

It's largely because of this that until now, magazines like *EA* have often given simple GW-BASIC programs to get our readers started with projects designed to hook up to a PC. We know that most of our technical readers (around 80%) have a PC, and that therefore they will have access to GW-BASIC, simply because it came bundled with so many machines.

Time changes all things, though, and one of the things that we all expect from computer programs nowadays is that they should have an intuitive and 'friendly' user interface. You shouldn't have to refer to a user manual before you can drive them; it should be quite clear from the interface itself. Not only that, but the programs should be *rugged* — hitting the wrong key by accident shouldn't make them fall in a heap.

Now given a fair bit of experience and plenty of time, you *can* do all of this



This is the basic screen you see in VBDOS's Form Designer, which you use to design the user interface or 'front panel' for your program. You're provided with a tool kit of control objects — things like text boxes, control buttons, and pull-down menus, which already 'know' how to respond to events such as mouse clicks and key presses.

even with an elderly traditional BASIC like GW-BASIC. But generally you can't do it when you're writing 'quick and dirty' programs.

In fact with a language like GW-BASIC, providing a program with a really good user interface tends to involve about 10 times as much work as the actual 'crunching' part of the program.

A traditional BASIC like this just wasn't designed for doing such things...

Enter Visual BASIC

When Microsoft released its *Visual BASIC for Windows* a couple of years ago, it created quite a stir even among people who had previously looked down their noses at BASIC.

Here at last was a language that was designed specifically to produce programs with friendly, intuitive user interfaces — yet at the same time, one that was really easy to drive and clearly derived from traditional BASICs (although significantly different from them, as we'll see shortly). Needless to say, even the pro's took to *VB for Windows* with gusto, and it has apparently been used to turn out all kinds of friendly applications programs for the *Windows* environment.

The only real shortcoming of *VB for Windows* is that in order to run it and the applications it produces, you do need to have a machine running *Windows*. Nowadays this tends to mean at least a fairly fast 386 machine with 4MB or more of RAM, plus of course *Windows* itself as well as DOS. Which means it isn't really all that suitable for a lot of the situations where somewhat slower and lower-cost machines (there are still large numbers of them) are used to monitor and control other equipment. For which they're perfectly suitable, of course.

It was presumably a realisation of this which prompted Microsoft to develop its 'half brother' product *Visual BASIC for DOS*, which appeared more recently. As the name suggests, *VBDOS* provides most of the features found in *VB for Windows*, but is designed to work directly on the DOS platform — making it more suitable for use on low-end machines.

In short, it's the new *VBDOS* which is probably more of interest to people like we electronics types, working as we often do with various pieces of equipment hooked up to our PC's and getting them to communicate with each other. That's why I was very interested in getting hold of a review copy of *VBDOS*, to try it out.

Different approach

Like its *Windows*-based brother, *VBDOS* is rather different from conventional BASICs (and many other traditional programming languages, for that matter). It's designed to produce programs that are mainly *event-driven*, rather than top down — so they do things in response to stimulus events. This means that a *VBDOS* program tends to consist not of a single large block of code, but instead of a lot of separate modules, each of which is called into play in response to a particular event — like the user pressing a particular key on the keyboard, or a data byte arriving at the RS-232C port, or whatever. In a sense, each module is rather like a 'macro' or a subroutine, dedicated to a particular task.

The other thing that's very different about both versions of Visual BASIC is that they're provided with a very powerful set of screen *objects*, which are designed expressly for the purpose of making user interfaces.

If you've used *Windows*, or even many of the more recent DOS-based programs with a graphical-type interface, these screen objects will already be quite familiar to you. There are things like text input and display boxes; list boxes and dialog boxes; drop-down menues; check boxes; vertical and horizontal scroll bars; command buttons and option buttons; labels; and so on. In short, all of the components which are used to produce a friendly user interface, able to be operated using either the keyboard or a mouse.

Because *VBDOS* works under DOS, it doesn't have access to the fancy graphics capabilities of *Windows*. As a result its screen objects are currently all based on text and 'character-based' graphics — so they're a bit chunky. This includes the mouse cursor, which is normally a character-sized rectangle. But nonetheless you get a very extensive toolkit of these objects, and they're all programmable in terms of their screen properties: size, position, colour, label text and so on.

Most importantly, of course, they're not just pre-cooked visual screen images, but already endowed with inbuilt 'intelligence' when it comes to interacting with the keyboard/mouse or your program. For example the text input box object knows how to accept text from the keyboard; a command button object can tell when the mouse cursor is positioned on it and one of the mouse buttons is clicked; a scroll bar object can move its 'elevator button' in response to mouse clicking or dragging, and can provide information on any changes that occur; and a pull-down menu object knows how to move its highlight bar down over its entries, and can advise which menu item was selected when the mouse button is clicked.

What this means is that when you design your user interface using these objects, a lot of your program's housekeeping is already solved, in embryo form. Each object effectively has a built-in software module and interface, which can respond to keyboard, mouse or other system events. All you have to do is provide the remaining code, to link all of these separate interfaces together and cause the right actions to occur, in response to the various events.

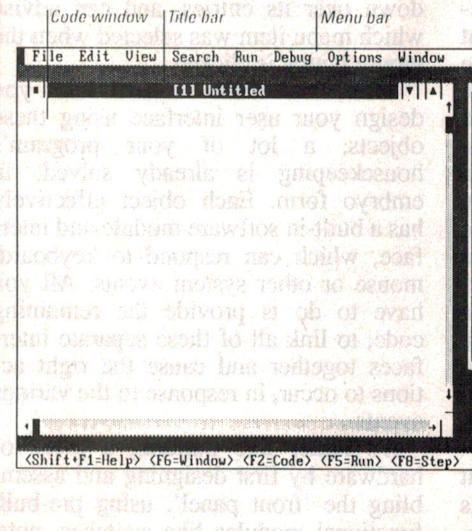
It's rather like building a piece of hardware by first designing and assembling the 'front panel', using pre-built functional modules like switches, pots,

keypads, display panels, etc. Then you swing the panel over and complete the equipment simply by adding the wiring between their rear connection lugs.

In keeping with this two-step approach, *VBDOS* actually consists of two main modules. There's the 'form designer' *FD.EXE*, where you design and assemble your 'front panels', using its toolkit of control objects; and there's the 'programming environment' or *VBDOS.EXE* itself, which is then used to add the code which links them all together, and run and debug the completed programs. Even here things are easier than you'd think, because *VBDOS.EXE* generally provides a 'template' for the code routine used to interface to each control object — so often all you have to do is 'fill in the blanks'.

Needless to say, both *FD.EXE* and *VBDOS.EXE* are themselves provided with a full character-graphics GUI, and are just as user-friendly as the programs they help you create.

As well as these two main modules, *VBDOS* also provides *BC.EXE*, a compiler which can turn your completed and debugged program into either a free-standing (and fast) EXE file, or a file which runs with a standard run-time module. There's also *LEARN.EXE*, a tutorial for *VBDOS*; *FT.EXE* and *TRNSLATE.EXE*, which can handle translation of forms and complete programs between *VBDOS* and *VB for Windows*; a couple of 'toolkits' with additional control objects; and an impressive set of sample programs, many of which can be adapted for other applications (as well as studied to see how things are done).



The other main module of VBDOS is the programming environment, which looks like this. You use this environment after you've designed your form, to provide the code 'connections' between all of the control objects.

All of the modules described so far come in the 'Standard' edition of *VBDOS*, by the way. If you want even more, you can go for the 'Professional' edition which adds *CUSTGEN.EXE*, a module which lets you design your own custom control objects with embedded code; *PROFILE.EXE*, *VBDPROF.EXE* and *TRACE.EXE*, three utilities which allow you to optimise program performance; five additional toolkits, with objects for adding charting and graphing, on-line help facilities, program install facilities, matrix maths and financial calculations; and some additional sample programs.

With the Professional version you also get a set of additional EXE modules which provides *VBDOS* with further powerful built-in functions for database management using ISAM (indexed sequential access method).

Trying it out

Microsoft very kindly provided a review copy of the full Professional edition of *VBDOS* (Version 1.0) for review, and so far I've spent more hours than I'd like to admit, trying it out. After installing it in my 'standby' 12MHz/286 machine (it needed just over 11MB on the hard disk), I first of all ran through the interactive tutorial to get a basic 'feel' for the way *VBDOS* works. Then I looked at some of the sample program 'projects' that came with the package, to get a closer look at the 'nitty gritty'. And the rest of the time, I've been pottering around creating forms and little test programs of my own.

At present I have to admit I've still really only scratched the surface of *VBDOS*. I intend spending a lot more time with it, though, because already I can see what enormous potential it *does* have for 'our kind' of programming — that is, creating the sort of programs we electronics people tend to need a lot when we're connecting up our PC to other equipment.

For those like me who have spent a fair bit of our working lives writing programs in conventional languages like GW-BASIC, FORTRAN, assembler and C, it does take a little time to adjust to the object-oriented and event-driven aspects of *VBDOS*. But once you do, the impact of this new approach to programming really hits you.

There's no doubt that *VBDOS* provides you with the ability to produce friendly, intuitive programs which are at the same time well structured and relatively 'bulletproof' — and all this in a remarkably painless fashion. This is programming as it *should* be — quick and easy, but no longer needing the 'dirty' tag as well...

In general, then, I'm very impressed indeed with *VBDOS*. Even the Standard edition should be of great potential value for electronics people, as it provides just about everything needed for this type of application.

In fact so far I only have one complaint. Because both versions of *VBDOS* are locked into character-based graphics for their 'forms' and 'control objects', you can't combine these items with high-res graphics. If you want to have a program with high-res graphics, these have to be in a separate 'desktop' screen which is only visible when no forms and controls are being displayed — and vice-versa.

I gather this shortcoming isn't present in *VB for Windows*, which like other *Windows* applications runs in full graphics mode. Hopefully Microsoft will remove the shortcoming in later versions of *VBDOS*, too (please?).

Despite this criticism, there's no doubt that *Visual BASIC for DOS* represents the next dramatic step forward in the evolution of BASIC as a programming language for lower-end applications.

The quoted list price for the Standard edition of *VBDOS* is $295.00, with a corresponding price of $765 for the full Professional edition. However you can probably get them for somewhat less, if you shop around.

Both versions should be available at any of the larger software suppliers, but if you have any difficulty, information on your nearest stockist is available from Microsoft at 65 Epping Road, North Ryde NSW 2113; phone (02) 870 2100, fax 805 1108. ❖

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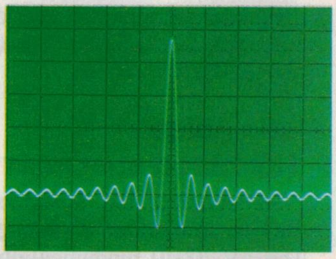

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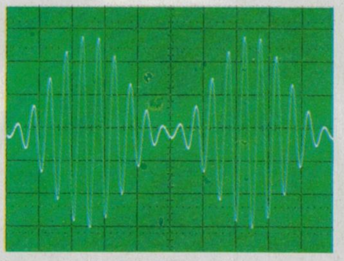

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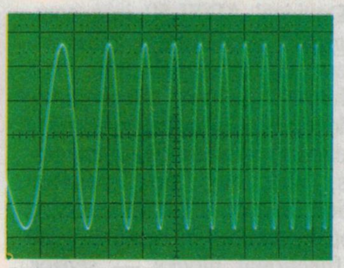

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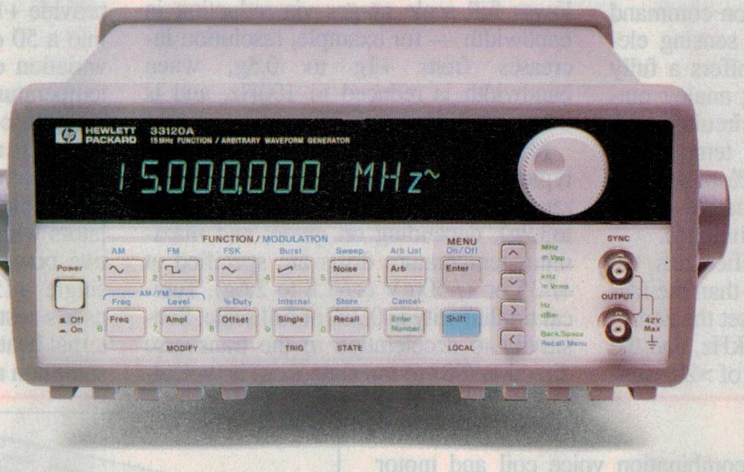

The HP 33120A 15 MHz synthesised function/arb generator: Within budget, without compromise.

In the world of function generators, price and performance have always been synonymous. So it's understandable you'd expect to pay more for the measure of confidence you get with a synthesised signal source that delivers stable, accurate signals test after test. Or, for the flexibility to generate complex waveforms with arbitrary waveform capability.

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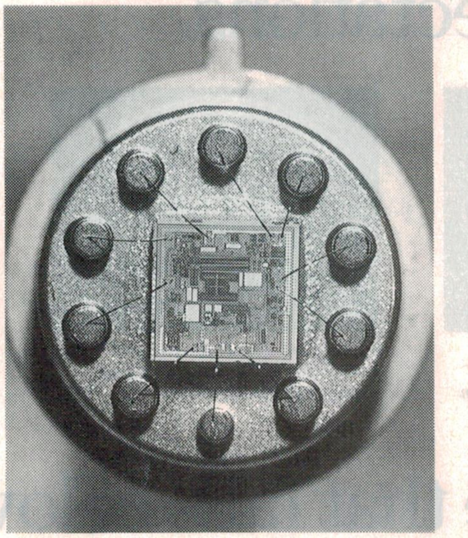
Acceleration measurement IC

Analog Devices' ADXL50 is a complete, integrated acceleration measurement system on a single chip. The micro-machined silicon technology originally developed for airbag systems is now broadened to industrial/instrumentation needs, with two new versions demonstrating the same high reliability as the automotive version. Incorporating all necessary functional blocks — sensor, modulator, demodulator, oscillator, reference, amplifiers, and self-test circuitry, the easy-to-use device has applications which include vibration analysis, shipping recorders, motion/position sensing, and instrumentation and test.



With maximum measurement range spanning 0 to +/-50g, single +5V operation, and complete self-test on command — including testing of the sensing element itself — this device offers a fully scaled, conditioned 19mV/g analog output. Due to compensation circuitry, performance over operating temperature range is more stable (+/-75% of reading for the J grade) than alternative piezoelectric or piezo-resistive techniques.

An internal buffer amplifier lets the user alter sensitivity to other than the factory-set 19mV/g, as well as set the zero-g level. Bandwidth is DC to 1kHz, and the device can withstand shocks of >2kg (unpowered). The ADXL50 can be used at lower full scale ranges via reduction in bandwidth — for example, resolution increases from +1g to 0.3g, when bandwidth is reduced to 100Hz, and is 0.1g with 10Hz bandwidth.

Nominal zero-g output is 1.8V, with typical drifts over operating temperature ranging from +/-10 to 60mV (+/-0.5 to3.2g), depending on grade; and maximum temperature drifts are specified at +/-35 or +/-50mV (+/-1.8 to 2.6g). Typical nonlinearity is 0.2% of full scale. Sensitivity to acceleration in the transverse direction (90° to the main axis) is typically +/-2%, which includes both alignment and cross axis sensitivity error.

For further information circle 272 on the reader service coupon or contact NSD Australia, Locked Bag 9, Box Hill 3128; phone (03) 890 0970.

Low noise YIG-tuned oscillator

HP Avantek has introduced a 20 to 40GHz, low noise, YIG-tuned oscillator. The AV-20040 fundamentally covers the full octave bandwidth using a single yttrium iron garnet (YIG) sphere coupled with an internally produced, sub-micron gate length, GaAs FET transistor. As a result, the entire frequency spectrum is spurious free, guaranteed to be a minimum of -60dBc.

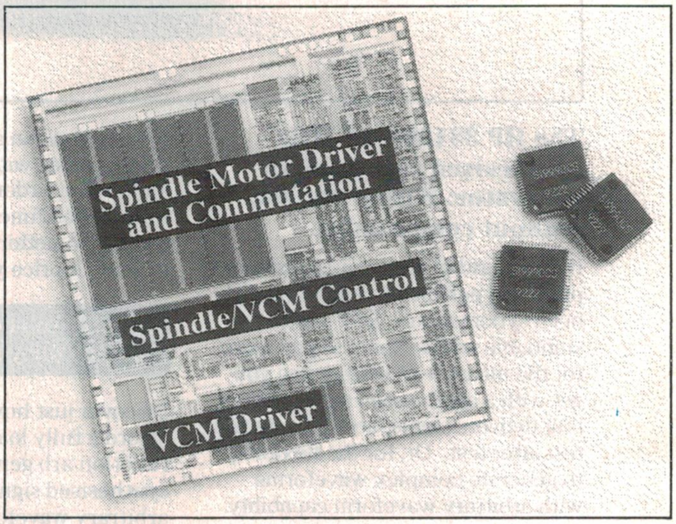
Three integral GaAs FET amplifiers provide +10dBm minimum output power into a 50 ohm load, with minimal power variation over the commercial operating temperature range of 0 to +65°C. The AV-20040 is constructed using thin film technology, making the oscillator very reliable, and the performance highly repeatable. Unlike other YIG-tuned oscillators which require a positive and negative power supply, the AV-20040 uses a single +15V DC bias, simplifying the user's system design. Furthermore, no internal heater is used, reducing power consumption and heat dissipation.

New disk drive IC

Siliconix has released a combination voice coil and motor driver IC, which controls the emergency retract of the disk drive head without using an external Schottky diode or transistor. The new Si9990CS also controls motor speed independent of the processor, freeing the microcontroller for more vital functions. As a result, the new device replaces two or more ICs, and therefore saves considerable space in 1.8 and 2.5" hard disk drives.

The new 5V Si9990CS delivers 0.3A of VCM current and 1A of spindle motor current. The spindle driver portion uses back EMF sensing for communications, and also contains an internal current sense resistor and a programmable start up current limit. Emergency retract of the head is provided by the spindle driver output structure.

The VCM driver has externally programmable gain and bandwidth, and programmable retract current with a fixed voltage clamp. A 300mA transconductance power amplifier reduces crossover distortion. In addition, the device has an automatic head retract, over-temperature protection, voltage monitor, sleep mode, and uncommitted amplifiers. Manufactured using a self-isolated BiC/DMOS process, the Si9990CS is available in a 64-pin SQFP, a 1.6mm high package.



For further information circle 271 on the reader service coupon or contact IRH Components, 1-5 Carter Street, Lidcombe 2141; phone (02) 364 1766, fax (02) 647 1545.

The oscillator is hermetically sealed to give long term environmental protection from moisture, even under severe humidity conditions. The AV-20040 is available in the Avantek standard M5-60 magnet body. The coaxial connector provides ease of installation, eliminating the need for waveguide.

For further information circle 274 on the reader service coupon or contact VSI Electronics (Australia), 16 Dickson Street, Artarmon 2064; phone (02) 439 4655, fax 439 6435.

Programmable peripherals for uC's

WSI has released two new families of field-programmable microcontroller peripherals. The PSD4XX and PSD5XX devices use up to 5000 gates of zero-power programmable logic to perform functions that are normally implemented either in real-time software (in microcontroller hardware), or in several tightly coupled peripherals.

The PSD4XX has two on-chip ZPLDs with a total of 59 inputs and 120 product terms in 24 macrocells. The PSD5XX has three on-chip ZPLDs with a total of 61 inputs and 140 product terms in 30 macrocells.

The programmable microcontroller functions and programmable logic are connected by a PLD bus with external I/O that operates independently of the microcontroller. This frees up the microcontroller to perform other functions, resulting in increased system performance. Alternatively, designers can use a simpler and less expensive microcontroller to achieve the same system performance and functionality.

The PSD4XX/5XX also have an automatic power-down unit; up to 1MB of EPROM; 16KB of battery-backed SRAM; a 4-bit page register; five configurable 8-bit I/O ports; a security bit; and a configurable interface to any eight or 16-bit muxed, or non-muxed microcontroller. In addition, the PSD5XX devices include four 16-bit timer/counters and an eight level interrupt controller. Logic design, simulation, timing analysis and programming of the devices is performed using WSI's device-specific PSDsoft software.

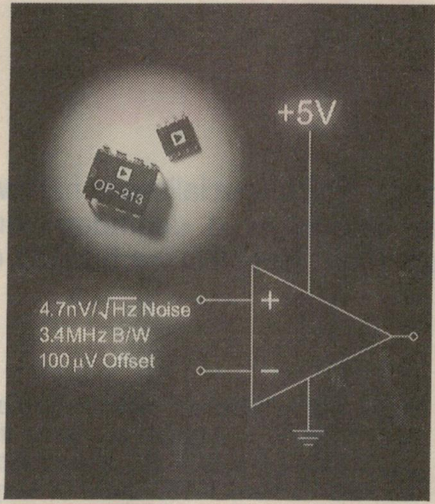
PSDsoft will run on 386/486 PCs under Windows, and will integrate the ABEL hardware description language (AHDL) used for design entry and logic optimisation, and SILOS III for behavioural, logic, switch simulation and timing analysis.

For further information circle 280 on the reader service coupon or contact Zatek, PO Box 397, West Ryde 2114; phone (02) 874 0122, fax 874 6171.

New single supply op-amps

Analog Devices has introduced three new monolithic single-supply op-amps.

The OP-495 is a precision, quad, rail-to-rail output amplifier. Key features include: +3 to +/-15V (+36V) operation, low offset voltage (300uV), ability to drive capacitive loads (300pF), 75kHz gain bandwidth product, and 150uA maximum supply current per amp. This device, a quad version of the OP-295, dual op-amp is intended for battery-powered instruments, servo amplifiers, sensor conditioners, and other single-supply applications.



The OP-113 and OP-413 are single and quad versions, respectively, of the OP-213 dual, single-supply precision amplifier. For supplies from +5 to +/-15V, these op-amps feature low noise (4.7nV/√Hz), 3.5MHz bandwidth, 100uV offset voltage, and drift of just 0.8uV/°C. Applications include automotive, process control, portable instruments, and pressure/strain gauges.

For further information circle 276 on the reader service coupon or contact NSD Australia, Locked Bag 9, Box Hill 3128; phone (03) 890 0970.

Micropower comparators

The Maxim MAX921-MAX924 single/dual/quad low-voltage, micropower comparators include a 1% precision reference. These combination comparator/reference ICs feature a very low power consumption, making them ideal for 3V or 5V single-supply applications. The MAX921 single comparator draws less than 4uA over temperature. It includes an internal 1.18V +/-1% voltage reference, programmable hysteresis, and TTL/CMOS outputs that require no external pull-up resistors — all in an 8-pin DIP or small-outline package.

These comparators continuously source as much as 40mA, enabling them to function as high-side 12 ohm switches. And by eliminating the power-supply glitches which commonly occur when comparators change logic states, the MAX921-MAX924 minimise parasitic feedback. Propagation delay is only 23us with 10mV of overdrive. The comparators operate from a single 2.5V to 10V supply or from dual +/-1.25V to +/-5V supplies, and the input voltage range extends from the negative supply rail to within 1.3V of the positive rail.

The MAX921 single comparator with reference, MAX922 dual comparator, and MAX923 dual comparator with reference all come in eight-pin DIP and SO packages. The MAX924 quad comparator with reference is available in 16-pin DIP and SO packages.

For further information circle 277 on the reader service coupon or contact Veltek, 18 Harker Street, Burwood 3125; phone (03) 808 7511.

Programmble-gain instrumentation amps

Burr-Brown's new PGA204 and PGA205 are monolithic digitally programmable instrumentation amplifiers. PGA204 provides decade gain steps: 1, 10, 100, 1000V/V; while PGA205 has binary steps of 1, 2, 4, 8V/V. Gain is selected by two TTL or CMOS compatible address lines. Designed for data acquisition, PGA204 can extend dynamic range of 12-bit converters to over 20 bits. Their precision, versatibility, and low cost make them ideal for a wide range of applications including process control, medical instrumentation, test/measurement equipment, and general-purpose analog boards.

The amplifiers achieve OPA177-like performance; offset voltage is 50uV (max) drift is 0.25uV/°C (max), gain error is 0.024% (max) and nonlinearity is 0.002% (max). The input bias current is less than 2nA. Power supplies can range from +/-4.5 to +/-18V, and supply current is a mere 5.2mA.

Designed to be robust and easy to use, the amplifiers have analog inputs which are internally protected for overloads up to +/-40V — even with power supplies turned off. Flexible logic inputs accept CMOS/TTL or high level inputs. No separate logic supply is required.

For further information circle 275 on the reader service coupon or contact Kenelec, 2 Apollo Court, Blackburn 3130; phone (03) 878 2700. ❖

PC-based PLC system upgraded

Melbourne-based Procon Technology, which specialises in hardware and software for using a PC as a programmable logic controller, has released upgraded versions of both its I/O cards and proprietary programming language 'PLC'. Recently we had the opportunity to look at the new versions and try them out.

by JIM ROWE

Back March 1991, we reviewed some of the hardware and software which local firm Procon Technology had developed so that low cost IBM-compatible PCs could be used as programmable logic controllers. At that stage the company had a range of very nice I/O boards, which hooked up to the PC via a slightly modified parallel printer port, and also a programming language they had developed called *PLC*. This was designed to help people who were more familiar with 'relay ladder logic' than conventional computer programming languages, so they could write and debug programs for industrial monitoring and control.

Since then, it seems that Procon has been busy upgrading both its hardware and software products, and recently its manager and chief engineer Peter King sent up samples of some of the latest versions, with the suggestion that we might like to try them out and compare them with the previous versions. That's the background to this follow-up story.

One of the most popular series of I/O boards in the Procon range is the PC-IO-XX series, each of which provides eight relay-switched outputs and eight opto-isolated inputs. These boards can connect to a PC via either a standard parallel port or Procon's own bi-directional port card, and they're addressable so up to 15 boards can be daisy-chained to a single parallel port (providing it's compatible). This means that a PC can be provided with as many as 120 relay outputs and isolated inputs, if necessary.

Probably the most popular board in this series is the PC-IO-NR-12VAC, which forms part of Procon's 'I/O Starter Pak' as well as being available separately. This provides eight opto-isolated, debounced and filtered inputs designed to take 12V AC or DC (isolated to 1000V RMS), and the same number of outputs via SPDT relays with gold/cobalt contacts rated at 110V/0.3A AC or 30V/1A DC. All inputs and outputs are individually addressable. The PC-IO-NR-24VAC board is very similar, but the inputs are designed for 24V AC or DC input.

Other I/O boards in the Procon range include the PC-IO-DK series, fitted with 10-amp SPST relays for the outputs, and the PC-IO-NR2/DK2 boards, which are output-only boards featuring 16 relay-switched outputs.

The -NR2 board provides 16 SPDT 1A relays, while the -DK2 provides 16 SPST 10A relays. Boards with relays capable of switching 250V/10A AC are also available, as is an ADC/DAC analog I/O board which offers 12-bit resolution and input data conversion rates of better than 10kSps.

The sample board sent to us by Procon, and visible at front centre in the picture, is the latest version of the PC-IO-NR-12VAC. The original version of this board was very well laid out, but this new version appears to have been completely re-designed and is even neater. Even more than before, it manages to combine compact size with sturdy construction and solid, practical terminal blocks for the many inputs and outputs.

As before, the board is quite flexible when it comes to power supply arrangements. There's an on-board rectifier, filter and regulator which can be used to power it from an unregulated supply of either 7 - 12V AC or 9 - 16V DC, but the board can also be powered from a source of regulated 5V DC if this is available. The Procon bi-directional parallel port card is in fact provided with a banana jack, so that the board can be powered from the 5V rail in the PC.

Even in its original form, the PC-IO-NR-12VAC board provided a fail-safe feature. When power is first applied, all outputs were reset to the OFF state to ensure orderly re-initialisation following a power failure. The new version retains the same feature, but also provides an optional 'watch-dog' feature which can be set to disable the output relays if the PC has not written to that address for a preset time interval (either 150ms or 1s).

Although this feature can be disabled if not needed (or for compatibility with the earlier version), it may be very desirable in applications where machinery could be damaged, or personnel injured, if the PC should 'crash' or its software gets stuck in a loop due to a sensor problem. So it seems a valuable enhancement.

The other new hardware item sent to us was the PC-BD-IO card, visible in the centre of the picture. This is the latest version of Procon's 'enhanced' parallel printer port card, designed to ensure reliable operation of up to 15 of the I/O boards.

The original version of this card, as sent to us last time, appeared to be basically a standard PC printer port card with custom modifications. As well as a mod for full eight bit bi-directional operation, all input lines were fitted with pull-up resistors, for reliable operation with the full 15 I/O cards. A banana socket had also been added to the rear mounting bracket, to make the PC's regulated +5V rail available to power an I/O board.

Here again, the new version has been completely re-designed and now looks to be locally manufactured by Procon itself. This has allowed them to incorporate a more flexible I/O addressing system, so that the card can now be set for any of the I/O addresses used in PS/2 machines and laptops as well as standard PC/XT/ATs and clones. The actual addressing is now done elegantly via jumper shunts, whereas the original card used solder links.

The software side

When hooked up to a PC, a set of Procon's I/O cards can easily be programmed in almost any high-level language — using standard input and output commands to communicate with the boards. In fact most of the boards come with a floppy disk with demo, system test and setup programs for use with GW-BASIC, Quick BASIC, Turbo BASIC, Visual BASIC, Quick C, Turbo C and Turbo Pascal (including source code for adaptation to other compilers).

However to make it easier to use the boards for PLC applications, especially in the case of users whose background is mainly in the area of traditional logic controllers and 'relay logic', Procon also developed a proprietary dedicated language known as *PLC*. Or more strictly, *two* such languages, of which *PLC* is the basic level and *PLCX* the extended version. Both are able to operate in either 'foreground' or 'background' mode, the latter allowing equipment or processes to be monitored or controlled while the PC is being used for other 'foreground' work.

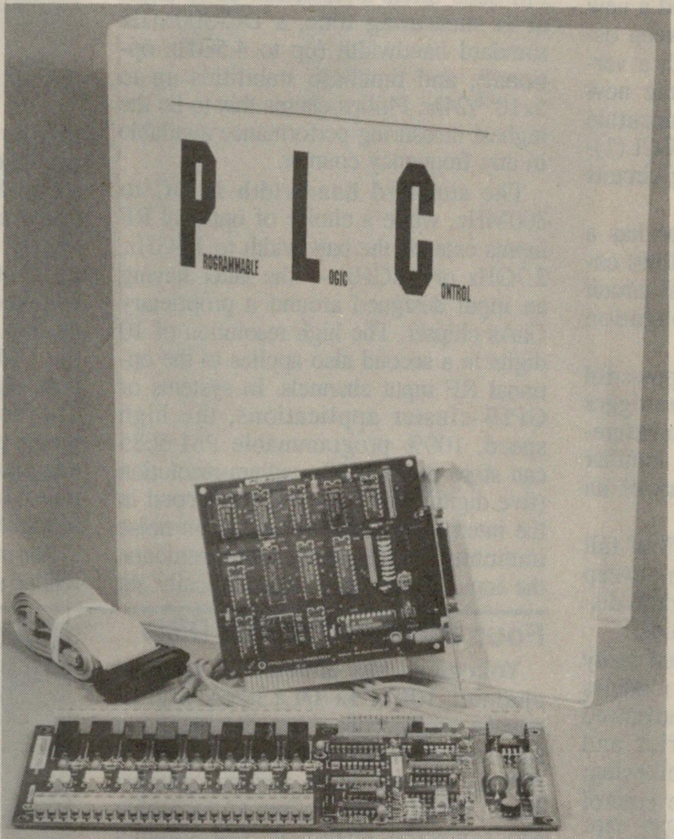
The latest version of *PLC* is V3.00, which supports up to 24 inputs and 16 outputs, 128 internal 'control relays', 16 timers, 16 counters and program sizes up to 1000 'ladders'. Other features include on-line program editing, real-time monitoring of program status and the ability to 'force' I/O conditions.

Similarly the latest version of *PLCX* is V1.20, and as you might expect this provides expanded support capabilities: 128 inputs, 120 outputs, 512 control relays, 128 each timers and counters, and program sizes up to 4000 ladders with up to 2000 lines of comments (60,000 characters total).

Features recently added to both these versions of *PLC* include the addition of one-shot delay elements (up to 16 with *PLC*, and 128 with *PLCX*); shift register elements; set and reset coils (latch/unlatch control relays); flip-flop coils; master control relays (MCRs); and conditional jump (JMP), jump-end (JMPE) and conditional end (ENDC) operations.

There's now also an optional 'port in use' test when programs are initiated, the ability to use graphics characters in filenames, and a text-centring function when editing comment lines. An '/E' option also allows the editor to be called up with a program by your AUTOEXEC.BAT file, for easier development debugging of programs which normally run in background mode.

In addition to these enhancements, program operations have also been significantly speeded up. The input scanning rate is now better than 500 scans per second for *PLC* running on a standard 4.77MHz XT-level machine, while *PLCX* offers an instruction time of only 40ns when running on a 50MHz 486 — well and truly disposing of the myth that 'PCs are not fast enough for PLC work'!



Procon sent us a copy of the new V3.00 version of *PLC*, and we were able to spend a couple of hours trying it out. As with the earlier V2.5 we tried back in 1991, we found it quite easy to use once you get the hand of 'relay ladder logic'. The program's new facilities certainly give it additional flexibility, and it should now be suitable for programming a very wide range of PLC applications.

Finally, the remaining item sent up was a copy of the latest *PLC* user manual, pictured at the rear of the photo in its smart ring binder. We were a little critical of the manual we saw in 1991, which was a bit amateurish and had frustrating omissions of fairly basic information.

This being the case, it's a pleasure to report that the latest version of the manual is a vast improvement. Again it appears to have been totally re-done, and not only covers all of the basics but also provides a lot of useful reference information. There's even a list of books for recommended further reading about PLC's.

In fact the only thing we couldn't find much information about was the I/O jumper address settings for the PC-BD-IO card, when we wanted to make sure it wouldn't clash with the existing printer card in the PC we were fitting it to. Could this be covered with more detail in the next revision, please Peter?

This relatively minor criticism aside, though, the new manual is a much more impressive production than before, and now matches the professional standard of Procon's boards and software.

Conclusions

On the whole, we are very impressed with the latest upgraded versions of Procon's PLC products. Now more than ever, they seem to us to provide an excellent set of tools for using a PC as a programmable controller of real-world equipment and processes. It's heartwarming too, to be able to report that as well as now being fully made in Australia, they seem to be priced even more attractively than before.

For example the PC-IO-NR-12VAC and its 24V equivalent are currently priced at only $199 plus tax ($238.80 with tax), while the PC-BD-IO bidirectional card is only $120 plus tax ($144 with tax). Similarly V3.00 of the *PLC* language is $250, with V1.20 of the extended *PLCX* priced at $550. Upgrades of *PLC* from the earlier version 2.0 are currently available for only $100, but this is for a limited time only.

By the way, Procon is still offering its PLC Starter Pak, consisting of a bi-directional card for the PC, a PC-IO-NR-12VAC board, the necessary connecting cable (1m) and software (including *PLC* V2.5) for only $320 plus tax ($384 with tax). This would make an attractive way to get into PC-based PLC's, particularly as you can then upgrade to the latest version of the software at low cost...

Further information about these products is available from Procon Technology, PO Box 655, Mount Waverley 3149; phone (03) 807 5660, or fax (03) 807 8220. ❖

NEW PRODUCTS

TEST INSTRUMENTS

Low cost 500MHz DSO from H-P

Hewlett-Packard has introduced a new competitively priced delayed-sweep oscilloscope, the HP 54610A. With a vertical bandwidth of 500MHz, the new oscilloscope permits precise, accurate measurements of high speed, ECL(1)-based digital circuits and analog circuits greater than 150MHz.

The two channel oscilloscope has a viewable external trigger and allows engineers to make common digital circuit measurements, such as propagation delay, setup and hold times.

The instrument incorporates powerful digital features, such as pretrigger viewing, waveform storage and measurement automation, with the familiar controls and interactive display of an analog oscilloscope.

It offers an accuracy of 0.01% of full scale, and also has a maximum sweep speed of 1ns/division, fast enough to display the fast edges of ECL circuits.

The HP 54610A can be upgraded easily and inexpensively with add-on modules and software links to provide advanced analysis capability. Accessories and modules available include the following:

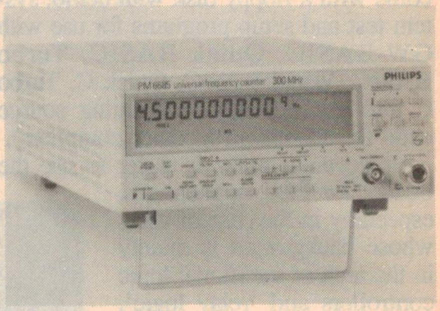
- interface modules for remote control and hard copy output to RS-232, HP-IB and parallel-interface printers and plotters;
- test automation modules for mask template testing and automatic sequencing with pass/fail testing and conditional branching;
- measurement/storage modules for enhanced performance, unattended signal monitoring and FFT(2) capability; and
- HP ScopeLink and Benchlink software packages for transferring screen images, waveforms, instrument setups and test automation sequences to MS-DOS(R)-based or Windows applications.

The HP 54610A comes complete with a power cord and two HP 10073A probes featuring Probe Sense. The price in Australia is quoted as $8840 (ex tax). For further information ring HP's hotline on 13 1347 (Australia wide).

Portable frequency counter

Fluke/Philips Test and Measurement has introduced the PM-6685 frequency counter, which makes calibration lab performance portable for the first time. The PM-6685 offers a resolution of 10 digits at 1s measuring time, a DC-300MHz standard bandwidth (up to 4.5GHz optional), and timebase stabilities up to 5×10^{-10}/24hr. Philips claims this to be the highest measuring performance available in any frequency counter.

The standard bandwidth is DC to 300MHz, while a choice of optional RF inputs extends the bandwidth to 1.3GHz, 2.7GHz or 4.5GHz — the latter having an input designed around a proprietary GaAs chipset. The high resolution of 10 digits in a second also applies to the optional RF input channels. In systems or GPIB-cluster applications, the high speed, 100% programmable PM-6685 can store up to 1600 medium-resolution (five digits) measurements per second in the internal memory. For optimum noise immunity in frequency measurements, the input sensitivity is automatically set



to one-third of the input signal's amplitude, with the trigger level always set to 50% of the amplitude. Thus optimum trigger setting with high noise immunity is always performed, irrespective of input signal waveform duty factor or amplitude. The Autoset function handles the vast majority of measurements. Also, the PM-6685 simultaneously displays both signal frequency and signal level. The built-in 3dB/segment analog bargraph gives at-a-glance confirmation of adequate signal level, eliminating the need to check signal levels with a separate instrument.

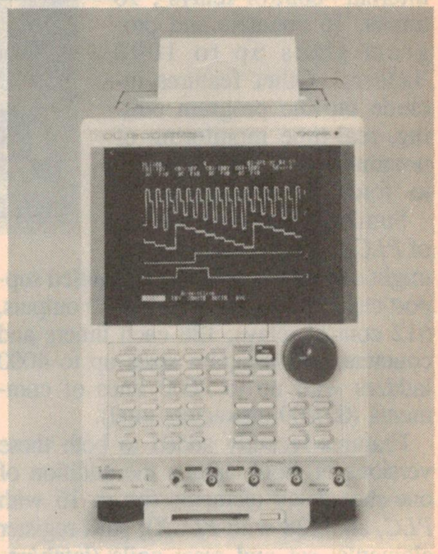
For more information circle 242 on the reader service coupon or contact Philips

Four channel 100MHz DSO

Yokogawa has announced its four channel 100MHz DL1300A digital storage oscilloscope. Featuring sampling speeds of 100MSps on two channels single shot, or 10GSps on all four in repetitive mode, the DL1300A offers up to double the sampling speed of Yokogawa's DL1200A model by doubling acquisition memory to 64K per channel.

A fast screen update rate allows the DL1300A to display incoming waveforms in real time, while simultaneously displaying up to 1000 times expanded segment of the same waveform — also in real time. The display is a high resolution amber raster-scan CRT. Several levels of brightness allow contrast between waveforms, measurements and grids to be adjusted.

The standard DL1300A is also provided with a GPIB interface, external trigger, and external clock interface, which allows synchronisation of the timebase to an external signal such as a data clock or shaft encoder. Automatic measurement facilities provided include RMS voltage, peak-to-peak voltage, frequency and rise/fall time. Two chan-



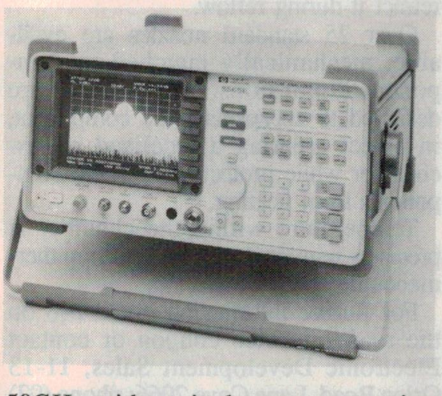
nels may also be tested by a GO/NOGO function, with the result causing waveform capture or an automatic hard copy printout.

For further information circle 241 on the reader service coupon or contact Yokogawa Australia, 25-27 Paul Street North, North Ryde 2113; phone (02) 805 0699, fax 888 1844.

Test & Measurement, 34 Waterloo Road, North Ryde 2113; phone (02) 888 8222.

Portable 50GHz spectrum analysers

Hewlett-Packard has announced two portable spectrum analysers, which offer preselected spectrum analysis up to



50GHz with a single-coax connection. The analysers are designed to meet expanding measurement needs in the communications, automotive, aerospace and defence industries.

The HP 8564E and 8565E provide what HP claims is the lowest noise floor above 26.5GHz, of any preselected spectrum analyser on the market. At 50GHz, sensitivity is -117dBm in a 10Hz resolution bandwidth, and third-order dynamic range is typically greater than 86dB. The combination of these features allows users to make distortion, spurious and sideband measurements quickly and confidently.

The single coax connection continuously sweeps all signals from 30Hz to 50GHz — this eliminates the need for external mixers. Because the preselector removes unwanted signals, users do not need to perform time consuming signal identification. The results are simplified operation and improved measurement speed and accuracy. The HP 8564E has a frequency range of 9kHz to 40GHz and the HP 8565E 9kHz to 50GHz. Both analysers have optional low end coverage to 30Hz and are preselected above 2.75GHz.

Other performance features include a precision frequency reference and counter that offer 1Hz frequency resolution and resolution bandwidth range of 1Hz to 20MHz; the ability to implement 79 user-defined amplitude correction points for increased measurement accuracy; sweep times of up to 2000s, which allow the use of narrow resolution bandwidths for wide-span sweeps; and a fast microprocessor that speeds command execution.

The 8564E and 8565E spectrum analysers cost $88,000 and $113,000, respectively. For further information phone HP on 13 1347 (Australia wide).

Sensitive cable/pipe locator

A sensitive metal detector from Fisher Detecting Equipment effectively eliminates the need for additional and expensive high powered fault tracers or locators. The M-Scope TW-6 is a cable and pipe locator and does all the traditional detecting tasks such as locating underground metal objects like pipes, cables, manhole covers, vaults and valve boxes, but is capable of significantly longer tracing. This is good news for water, telephone and electric power utilities, gas companies, petroleum pipeline operators and individuals such as plumbers and electricians, who need to know where to dig and more importantly, where not to dig.

The sensitivity of the TW-6 has also resulted in the removal of all unnecessary metal parts from previous models which could inhibit the tracing process. Both transmitter and receiver are crystal-controlled, while noise cancelling circuitry increases the clarity of the signal and cuts out background interference. A VCO also provides a wide signal range to indicate the presence of metal.

Powered by eight standard AA batteries in the transmitter and in the receiver, the standard TW-6 model is priced at $1295.

For further information circle 244 on the reader service coupon or contact Fisher Detecting Equipment, 2 Kiama Street, Miranda 2228; phone (02) 544 6111, fax 544 7766.

Calibrator for handheld DMMs

The Datron Division of Wavetek has announced the Model 9000 Multifunction Calibrator — claimed to be the first calibrator to provide complete test and calibration for all functions currently offered in handheld digital multimeters. Capable of testing and calibrating AC and DC voltage, AC and DC current, resistance, capacitance, conductance, pulse width, duty cycle, logic level, temperature and frequency to 10MHz, the model 9000 provides this comprehensive set of functions in a single test instrument.

It offers several innovative features that simplify the calibration process and significantly shorten calibration time. It combines fully variable active resistance, conductance, and capacitive test for ranges from zero to 400M, 0.5 to 2.5m-Siemens, and 500pF to 40uF respectively, offering improved flexibility when calibrating DMMs with differing scale multipliers. Active impedance circuitry provides a variable output signal to determine UUT error. Transparent ranging with automatic resolution adjustment enables the user to have continuous control over DC and AC output voltages from 1uV to 1.05kV and DC and AC currents from 1nA to 20A. This eliminates the need for separate transconductance amplifiers and significantly reduces the time required for test and calibration.

For further information circle 245 on the reader service coupon or contact Scientific Devices, 2 Jacks Road, South Oakleigh 3167; phone (03) 579 3622, fax 579 0971.

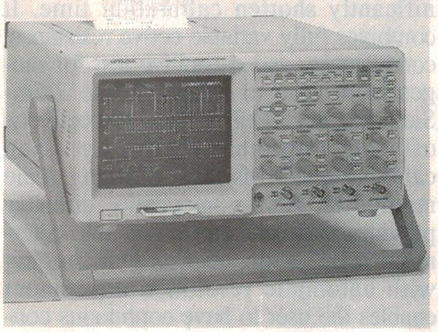
Analog circuit tester

The Transmission Measuring Set TMS-6 from Wandel & Goltermann is a new handheld, battery-powered instrument for field testing analog circuits. It performs measurements for commissioning and maintaining voice, low speed analog data, and other analog circuits in the range 20Hz to 20kHz.

The TMS-6 also has a frequency range of 200Hz to 200kHz for testing ISDN Basic Rate U-interface circuits. (ISDN U-interface re-uses the existing metallic pairs in the local network for Basic Rate transmission at 160kbps.) It measures wideband level, attenuation, crosstalk and noise. Swept results are displayed graphically on the high resolution LCD. Graphical results can also be stored in memory and printed on an external printer. Frequency response and attenuation distortion circuit characteristics in the range 20Hz to 20kHz can also be displayed. Easy judgement of circuit quality is made by comparing a curve with a tolerance mask. Both CCITT pre-programmed, and user-programmable tolerance masks are stored in memory and can be selected. The built-in microphone and speaker are for engineers to communicate across the circuit under test and to monitor the circuit for any signals.

For further information circle 246 on the reader service coupon or contact Wandel & Goltermann, 42 Clarendon Street, South Melbourne 3205; phone (03) 690 6700, fax 690 6750.

Multi-function DSO



The Hitachi VC-7104 is a four channel, 150MHz bandwidth 100MSps sampling speed digital storage oscilloscope. Single shot bandwidth is up to 25MHz, and storage/acquisition memory is up to 8k words/channels, with vertical resolution of eight bits.

Particular features of the 7104 are the built-in thermal printer, and a number of special trigger modes. These include trigger set up, window triggering, triggering after event count (up to 4k event count) and trigger after delay. TV triggering is also included. The scope has a number of pre-programmed automatic measurements, including go/no-go testing with a logical signal output, cursor measurement in voltage and time, and 17 pulse parameters. As well as the thermal paper printer which is built in to the top of the instrument, output modes include IEEE-488, plotter interface — and a digital RGB to multiscan colour monitor drive to directly display on a PC-type monitor screen.

For work on digital system waveforms, skew between the displayed channels is calibrated out. In common with earlier Hitachi scopes, waveforms can be stored on a memory card (now a standard JEIDA format card as opposed to the customer card used previously). A 2MB card will store up to 200 waveforms dumped from the screen.

For further information circle 287 on the reader service coupon or contact Warburton Franki, 1 - 5 Carter Street, Lidcombe 2141; phone (02) 344 1700, fax 647 1545.

Digital sound meter

Lucas CEL Instruments has announced what it claims to be the world's first all digital sound level meter. Designated the CEL-593 Sound Level Analyser, it converts signals from the microphone immediately into digital form using high resolution sigma-delta quantification techniques. From this data the broadband frequency weighting and time constants are calculated.

One of the many powerful features of the CEL-593 is the ability to allow simultaneous, real time measurements to be made of 14 parameters selected to have two frequency weightings, two time constants and two amplitude weights ('Q' values) in any combination.

The new instrument provides real time frequency analysis in octaves or third-octaves, in addition to a wide range of broad band noise rating indices. All are available with comprehensive time domain functions. This means that, together with the digital technology, the handheld CEL-593 provides the processing power and facilities normally only found in much bulkier instrument systems.

For further information circle 290 on the reader service coupon or contact AWA Distribution, 112 - 118 Talavera Road, North Ryde 2113; phone (02) 888 900, fax 888 9310.

TOOLS

Low cost desolder tool

The new value for money Solder Sucker from Scope Laboratories sells to the trade for under $10, and is available from normal Scope stockists.

It uses a tough see through plastic which helps you know when to clean out excess solder.

For further information circle 249 on the reader service coupon or contact Scope Laboratories, PO Box 63, Niddrie 3042; phone (03) 338 1566, fax 338 5675.

Hot air SMT rework station

OK Industries has released the FCR-2200 Series, a forced convection SMT rework system with vacuum pick-up. The system uses a self contained air source, and regulates air flow and temperature to rework a wide range of components, including discretes, SOIC, PLCC, and QFP. Three modes of operation provide manual or semi-automatic control for component removal or placement.

The advantage of forced convection heating eliminates damage to pads, boards or component leads when compared to direct contact heating methods. Once the component leads are desoldered, the FCR's vacuum pick-up lifts and removes the component.

The FCR-2200 handpiece has a spring-loaded vacuum tube which greatly reduces mechanical stress when contacting the component.

Additionally, the vacuum tube length is adjustable — the operator may extend it for better viewing during placement or retract it during reflow.

Over 25 standard nozzles are available, mechanically matched to component dimensions. The nozzles are designed to encapsulate the component, in effect creating a localised reflow chamber while protecting adjacent components from heating.

Temperature within the chamber is precisely regulated with closed-loop thermocouple control.

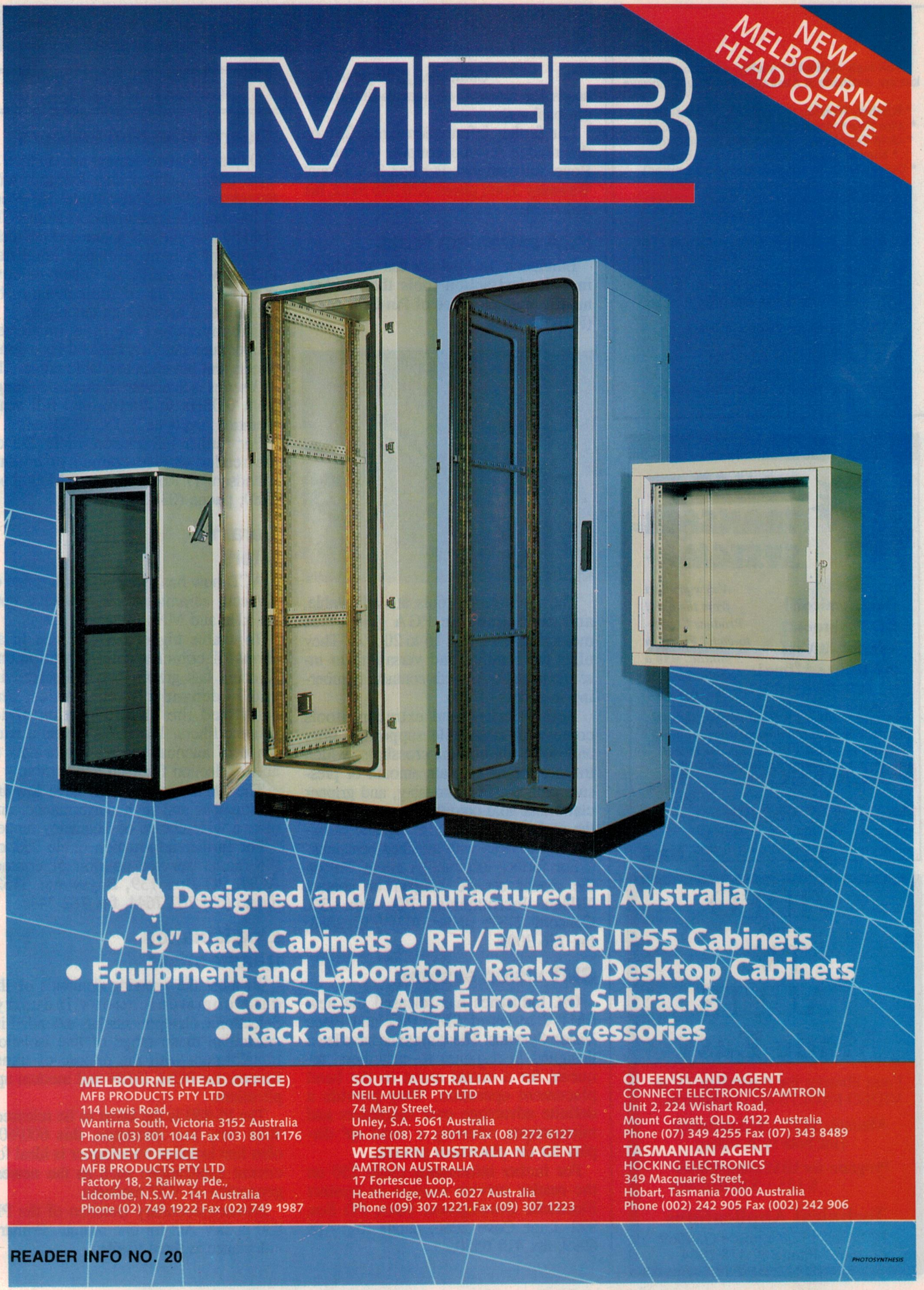
For further information circle 248 on the reader service coupon or contact Electronic Development Sales, 11-13 Orion Road, Lane Cove 2066; phone (02) 418 6999, fax 418 6550.

Pre-tinning mini solder pot

High temperature pre-tinning of fine wires and lead frames can cause embrittlement due to growth of intermetallics, and reduction in lead dimensions due to migration of lead frame material into solder alloy.

Australian manufacturer Royel International has introduced a miniature temperature controlled solder pot as an accessory to the ESD-safe Thermatic range of soldering and desoldering stations. This unit (Cat.No.AL400) with solder pot crucible SP400, can also be fitted with all lead reflow desoldering

Continued on page 148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Heatheridge, W.A. 6027 Australia
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QUEENSLAND AGENT
CONNECT ELECTRONICS/AMTRON
Unit 2, 224 Wishart Road,
Mount Gravatt, QLD. 4122 Australia
Phone (07) 349 4255 Fax (07) 343 8489
TASMANIAN AGENT
HOCKING ELECTRONICS
349 Macquarie Street,
Hobart, Tasmania 7000 Australia
Phone (002) 242 905 Fax (002) 242 906
READER INFO NO. 20
PHOTOSYNTHESIS

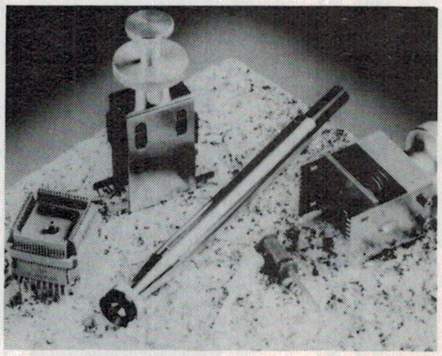
Continued from page 146

heads for removal of dual in-line multipin packages.

For further information circle 251 on the reader service coupon or contact Royel International, PO Box 328, Mount Waverley 3149; phone (03) 543 5122, fax 544 4894.

PGA extraction tools

Emulation Technology has introduced insertion/extraction tools that accommodate multiple sizes of Pin-Grid-Array (PGA) devices.



The multi-range tools are adjustable, and accommodate PGA grid sizes measuring from 16 x 16 to 20 x 20. They offer the stability and versatility to insert/extract PGAs with contacts numbering in excess of 300.

Both inserting and extracting tools come with adjustable supporting jaws and solid aluminium crossbars, which transfer the appropriate amount of pressure onto the PGA housing, and gripper claws that hold onto the bottom edges of the socket. They are also capable of extracting devices with attached heatsinks.

For further information circle 249 on the reader service coupon or contact Nilsen Instruments, PO Box 30, Concord 2137; phone (02) 736 2888, fax 736 3005.

SMT vision system

OK Industries has released the new SMT-V series of SMT Pick and Place Vision Systems. These systems have been designed in response to customers' requests for a visual assist to the hand placement operation. They provide a definite advantage over magnifiers and microscopes, allowing a 'head up' display for the placement process.

For further information circle 250 on the reader service coupon or contact Electronic Development Sales, PO Box 822, Lane Cove 2066; phone (02) 418 6999, fax 418 6550.

COMPONENTS

Quartz vibration sensors

Quartz vibration sensors are claimed to have taken 'another step forward' with the release of the 'Shear Mode' 353 series of low impedance transducers from PCB. Using the stability of quartz and the technology of a built-in charge amplifier, PCB saw the ability to further improve the performance of their sensors by moving to a new design technique.

Enhancements include improved temperature stability, reduced base strain effects and broaders available range. The 353 series is available in frequency range from 0.03Hz to 20kHz, and full scale vibration levels to 1000G (9.81km/s^2).

For further information circle 255 on the reader service coupon or contact Davidson, 17 Roberna Street, Moorabbin 3189; phone (03) 555 7277.

Ceramic filters

ACD now has available a full range of Kyocera ceramic filters, covering both the kHz and MHz frequency range.

To enable higher performance in all forms of communications equipment, Kyocera has greatly boosted selectivity and wideband characteristics, and stabilised the characteristics of its ceramic filters. The series covers a wide range of attenuation and bandwidths to allow selection for each application.

The filters are compact, have low insertion loss and high performance, and offer a wide choice of frequency range.

For further information circle 252 on the reader service coupon or contact ACD, PO Box 139, Bayswater 3152; phone (03) 762 7644, fax 762 5446.

Line isolation transformers

To meet the growing demands of the data communications industry, Selectronic Components has extended its Australian made range of line isolation transformers with the release of transformers for PCM, ISDN and modem applications.

The PI-830 is the latest to be released. With very low distortion, this 600/600 ohm line isolation transformer is ideal for critical applications such as the newest generation of V.32 modems.

Primary/secondary isolation of the PI-830 is 3kV AC for one minute. Primary inductance is three to 6H.

Distortion at -10dBm and 300Hz is -72dB, at 450Hz 77dB, and at 1kHz -84dB. Distortion at 0dBm and 300Hz is -68dB, at 450Hz -72dB, and at 1kHz -74dB.

For further information circle 281 on the reader service coupon or contact Selectronic Components, 25 Holloway Drive, Bayswater 3153; phone (03) 762 4822, fax 762 9646.

Measuring transducers

Sydney-based UPI manufactures a range of electrical transducers which can be used to convert instantaneous power signals into load-independent DC signals proportional to the measured value.

For instance, volts and current can be converted into watts, and give an output of 4 - 20mA (with a guaranteed accuracy class of 0.2). This output can then be connected to a recording device, data logger or computer; applications are numerous.

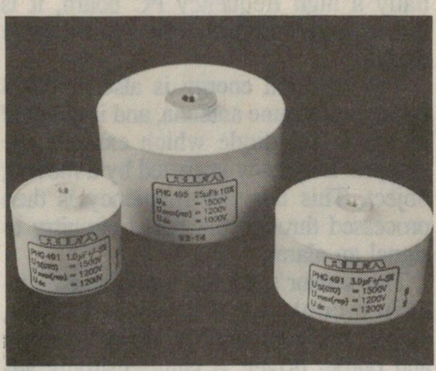
The range consists of current, voltage, watts, var, kVA, var-hr, var/var-hr, single, or three phase, balanced or unbalanced — with a range of outputs to choose from.

For more information circle 258 on the reader service coupon or contact UPI, 2/17 Melrich Road, Bayswater 3153; phone (03) 761 005, fax 761 0018.

Snubber capacitors

The PHG series of power capacitors from Evox-Rifa is designed for continuous operation under non-sinusoidal current and voltages, making the capacitors particularly suitable as IGBT and GTO thyristor snubbers.

Manufactured with a special metallised polypropylene dielectric, they are constructed in a flat pack format enabling very low inductances to be achieved, together with low thermal resistance — giving high current ratings of over 60A. The series are available in six ranges with voltage ratings up to 2.5kV, and capacitance range from 0.5 to 25uF.



For further information circle 251 on the reader service coupon or contact NSD Australia, 205 Middleborough Road, Box Hill 3128; phone (03) 890 0970, fax 899 5191.

Microwave capacitors

Designed specifically to meet the requirements of microwave applications, a new range of surface mount multi-layer ceramic capacitors from Philips has first and second parallel resonances guaranteed to be above 2GHz and 3GHz respectively, resulting in extremely low insertion losses.

For applications such as mobile radio, satellite TV and high frequency instrumentation, which operate at frequencies above 1GHz, these capacitors have advantages over standard capacitors for which high frequency performance is unusually unspecified. Philips' microwave capacitors are available in an 0805 case size with capacitance values between 0.47 and 82pF, and in a 1206 case size with values up to 120pF. They can supplied with either silver-palladium or nickel-tin terminations suitable for wave and reflow soldering.

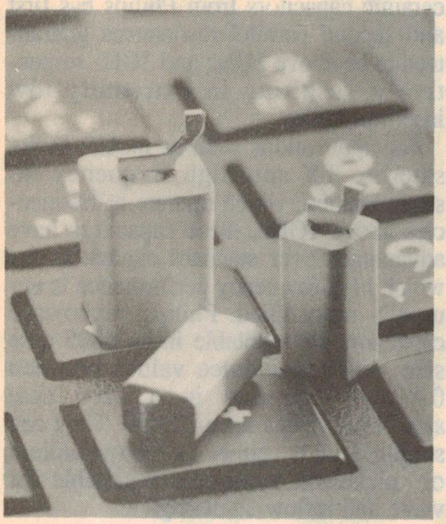
For further information circle 257 on the reader service coupon or contact

READER INFO NO. 21

Philips Components, 34 Waterloo Road, North Ryde 2113; phone (02) 805 4455.

Mini microwave ceramics

In electronics the trend towards smaller, lighter devices continues: mobile telephones, whose portable handsets fit into every pocket, are a particularly good



example. Smaller devices need smaller components, for instance, the new resonators from Siemens that have a cross section of only 4 x 4mm.

The new coaxial resonators are used in mobile communications devices and cordless telephones for frequency stabilisation of oscillators and — linked to bandpass filters — for attenuating undesirable frequencies.

They are available for frequency ranges of 400 to 2400MHz. A particular advantage of microwave ceramics resonators is that the operating frequency is variable, which means that the frequency can be modified electronically by about 5% for example for setting different radio channels.

For further information circle 254 on the reader service coupon or contact Siemens Electronic Components, 544 Church Street, Richmond 3121; phone (03) 420 7710.

Microwave motion sensors

AM Sensors of New Hampshire has introduced the DRO102 and DRO103 sensors, which provide low cost motion and proximity detection of objects and people using non-contract microwave sensing technology.

These sensors use microstrip design techniques to create a flat, compact microwave sensor with a broad detection pattern. Their small size and complete signal processing circuitry make them ideal for industrial and commercial OEM motion sensing applications, including part counting, process control, die ejection monitoring, obstruction warning systems and non-contract limit switching.

The microwave portion of these units uses a GaAs FET Dielectrically Resonant Oscillator (DRO) and Schottky mixer receiver diode mounted on a microstrip substrate. The energy from the transmitter (DRO) is launched into a microstrip 'patch' antenna array in order to focus the microwave energy into a detection beam. Because this microstrip circuitry is essentially a high frequency PC board, it is much more compact than a waveguide design.

The reflected energy is also received through this same antenna, and is directed to the mixer diode which extracts the Doppler frequency imparted by a moving object. This Doppler frequency is then processed through the board circuitry to signal an alarm.

The sensor's signal conditioning circuitry contains the power supply, amplifiers, comparators, delay circuitry and output driver. A gain/sensitivity adjustment is included to allow objects of various sizes, densities and distances to be selectively detected.

The DRO102 operates with a continuous wave microwave transducer — drawing more power than the pulsed transducer of the DRO103 — to provide a higher integrity 'analog output' signal for Doppler processing applications such as velocity.

For further information circle 285 on the reader service coupon or contact Electronic Development Sales, PO Box 822, Lane Cove 2066; phone (02) 418 6999, fax 418 6550.

Panel mount line filters

Timonta's range of RFI suppression filters provide a means of protecting instruments, circuits and appliances from harmful transients carried on the mains.

Suitable for OEM and industrial applications, they are available in chassis or panel mount versions — the latter with a standard IEC 320 plug input. Power switches are also available with built-in filter and optional built-in fuse. Most units have UL approval.

For further information circle 282 on the reader service coupon or contact Fastron Technologies, PO Box 1212, Dandenong 3175; phone (03) 794 5566, fax 794 6670.

COMMUNICATIONS

Flexible cordless phone

A new cordless pocket phone from Panasonic means consumers now have the convenience of a cordless, and the equivalent of two extensions on the one line, because they can receive and make calls from the base station or the cordless phone handpiece. The new model, designated KX-T4000AL, capitalises on the ultra compact, folding design of the KX-T3000BA.

In updating the design, Panasonic has added a dial pad to the base station to give consumers the option to make telephone calls hands-free, or transfer calls from the handset to the base station (or visa versa), while the cordless handset is in another part of their home or office.

The short flexible aerial is another improvement over the previous model, eliminating the likelihood of accidental breakage. Other major benefits are automatic intercom and the facility to avoid interference from other cordless phones using the 10 channel access selector as well as a built-in security system to prevent unauthorised access to the line. Its RRP is $569.

For further information circle 261 on the reader service coupon or contact Panasonic Australia, 1 Garigal Road, Belrose 2086; phone (02) 986 7400.

Transmission line tester

Meter International has released the AR-186T transmission line tester. It comprises a transmission test set, digital multimeter and telephone handset in one handheld instrument. The inbuilt transmitter and receiver are both capable of operation from 20Hz through to 50kHz and can operate at a fixed frequency, or

Continued on page 152

NEW PRODUCTS

Continued from page 150

swept frequency with user programmable step and time delay, with manual or automatic stepping.

The unit can operate on both two wire and four wire circuits, and is able to perform Return Loss Measurements on four wire circuits. The built-in dialler can dial using DTMF, Dial Pulse or MF methods, selected by the operator.

The instrument also includes multimeter functions appropriate to a telecommunications professional, including ACV and DCV to 300V, DC current to 300mA and resistance to 2M. It also includes capacitance to 100uF. The AR-186T also displays frequency to 50kHz on the ACV ranges on its 16 character by two line alphanumeric display with backlighting. Operation is from mains power or an inbuilt rechargeable battery with auto power off.

For further information circle 264 on the reader service coupon or contact Computronics International, 31 Kensington Street, East Perth 6004; phone (09) 221 2121, fax 325 6686.

Convenient fax/phone TAM

Two new five in one faxtams (combination telephone/fax/answering machine/copier/dictating machine) from Panasonic offer a high degree of convenience for people who work from home.

The new KX-F2350AL and KX-F2450AL incorporate an automatic telephone/fax switch with silent reception. This should not be confused with the auto answering machine/phone switch which it also has, but has been incorporated in previous models. Silent reception means you can be working at home and the phone will not ring until after it has assessed incoming tone for fax or voice reception. If it detects a fax tone, it goes into fax reception. If it doesn't detect a fax tone, the machine will ring so you may answer it.

If you prefer to leave it in manual mode, you can now answer your faxtam from any regular telephone extension, and simply press just one button to receive a fax should you hear the fax tone rather than a voice. Previously, it was a matter of running back to press the start button. RRPs are $1299 for the KX-F2350AL and $1449 for the KX-F2450AL.

For further information circle 265 on the reader service coupon or contact Panasonic Australia, 1 Garigal Road, Belrose 2085; phone (02) 986 7400.

PCM monitors

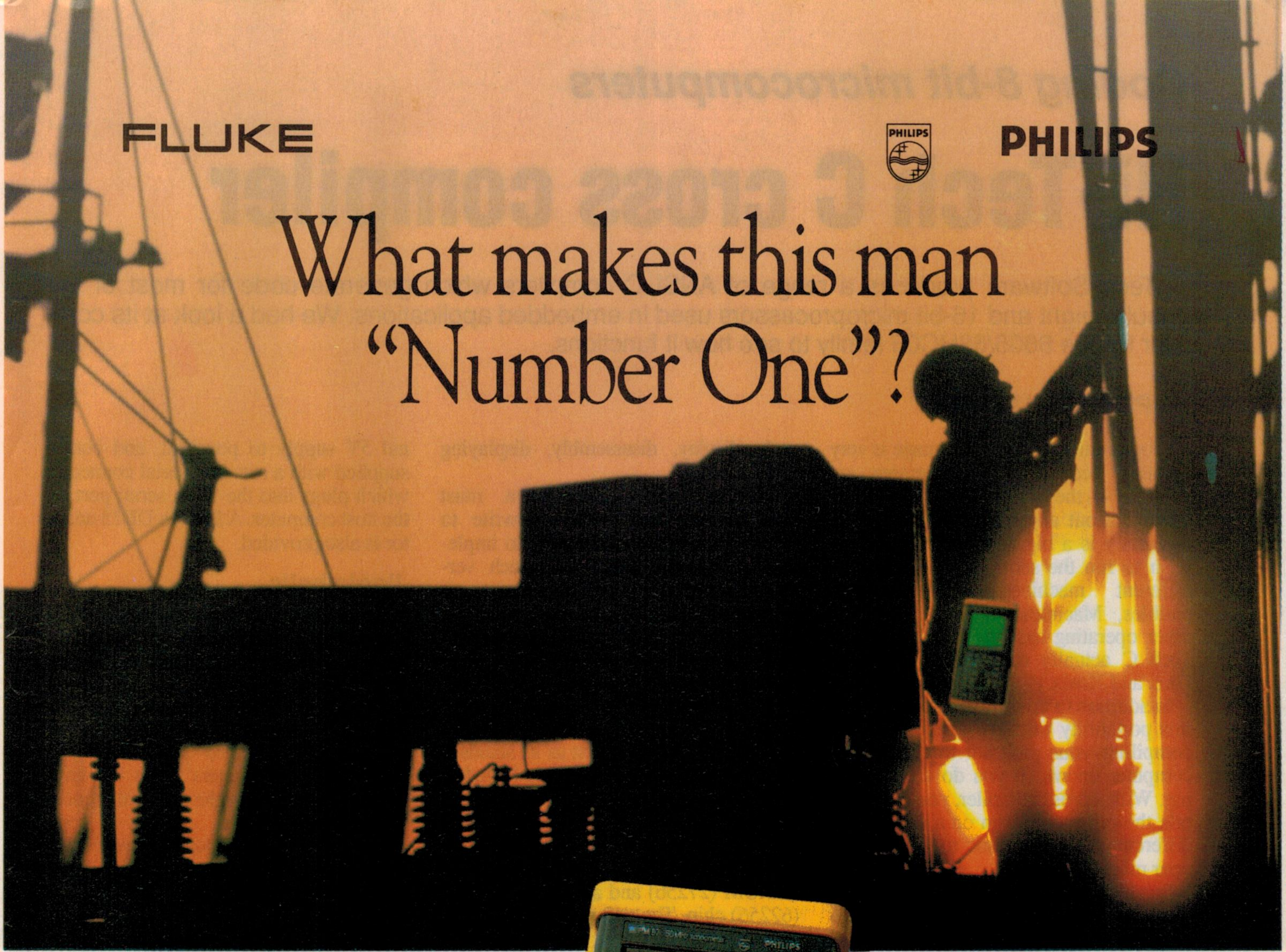
Available from Alcatel STR is the handheld family of Astroline PCM monitors. The three models that comprise the range are network independent tools, primarily used for the installation and maintenance of telecom networks and equipment.

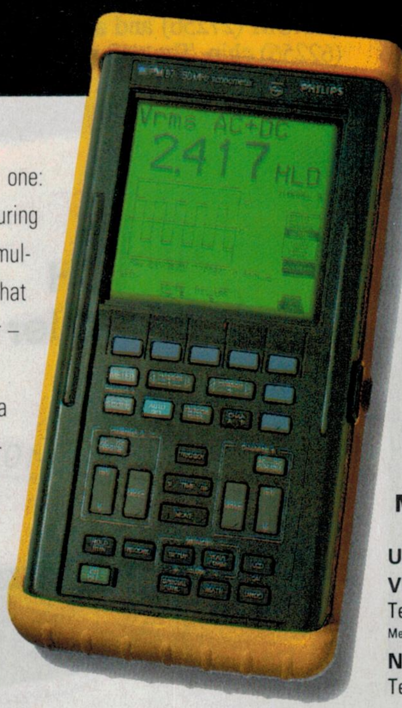
Astroline monitors provide audiovisual monitoring of 2048kbps PCM lines, and each unit can monitor two lines simultaneously. For each line, any time slot can be selected, monitored data is displayed on the liquid crystal display or rendered audible via the inbuilt speaker or headphone.

The units take the various signalling systems into account. There is the MCA-2 for channel associated signalling (CAS), model MC7 for No.7 signalling, and the MPRA for primary rate access (PRA).

Flexible DC or AC power supply options are provided, as is a 68-pole peripheral interface, allowing quick and easy connection to other measuring equipment.

For further information circle 283 on the reader service coupon or contact Alcatel Australia, 58 Queensbridge Street, South Melbourne 3205; phone (03) 615 6666. ❖





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READER INFO NO. 38

Coding 8-bit microcomputers

Hi-Tech C cross compiler

Hi-Tech Software produces a range of ANSI C compilers which generate code for most of the popular eight and 16-bit microprocessors used in embedded applications. We had a look at its compiler for the 6805/68HC05 family to see how it functions.

by PETER MURTAGH

Programming in the C language is very popular, because your programs are portable — they can be compiled to run on just about any microprocessor. This obviously is a big advantage when you wish to run the same program on such different machines as IBM-compatibles, Macintoshes, or those using other operating systems like Unix. (Hi-Tech C actually runs under MS-DOS, Unix and Xenix.)

In addition to this, cross compilers take this portability one step further, beyond compiling your program to run on the computer on which you do the compiling. With a cross compiler, you can compile the program to run on a completely different microprocessor to the one in your machine.

So, the 6805/68HC05 cross compiler program of this review runs on the 80x86 processor in an IBM-compatible computer, but produces the operating code required by either a 6805 or a 68HC05 processor. With it, you can build up complex interrupt-driven applications in C, without ever needing to write any 6805-specific assembler code.

The Hi-Tech compiler package also includes 'Lucifer' (heaven knows why it is called that!), which is a C source level and assembler level debugger, configured to run on your PC and talk to the target hardware via a serial line.

Lucifer allows you to exercise full control over the program running on the external processor. You can step through the code, correct errors, add in more code — all via the keyboard on the parent machine. The host program provides the user interface, including source code display, disassembly, displaying memory, etc.

Of course, the target system must have the logic to read and write to memory and registers, and to implement single stepping. With each version of Lucifer, a small program is provided which can be compiled and placed in ROM in the target system to implement these features. The monitor ROM supplied is configured for 19,200 baud operation.

To help us check out all the features of its compiler, Hi-Tech sent us its standard 68HC05 debugger board. This includes, in addition to the 68HC05 microprocessor, eight LEDs and a 50-ohm speaker connected to various outputs on the processor. There is also a 32K x 8 EPROM (27256) and a 32K x 8 SRAM (62256) chip. The unit requires an external 5V supply to power it, and comes supplied with a standard serial connector which plugs into the 9-pin serial port on the host computer. A DB9 to DB25 adaptor is also provided.

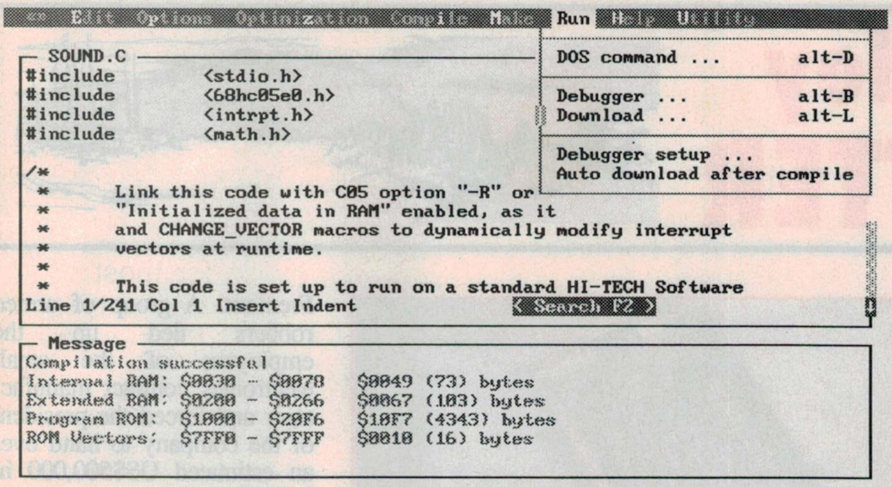
Jingle bells

One of the sample programs provided is called 'Sound', and plays Jingle Bells on the debugger board's speaker. But before you can hear this tune, you have to go through various steps.

First you must compile the debugger console I/O module, TGETCH.C, in order to 'get characters' from the keyboard for controlling the assembler code. Once TGETCH's object code TGETCH.OBJ is created, you can proceed to compile the sample program. This is easily done using the HPD05 program, which runs an integrated environment, with typical mouse-driven pull-down menus and commands. You use the MAKE option in the MAKE menu to compile the SOUND.HEX code, then the DOWNLOAD option in the RUN menu to squirt the code to the 68HC05. Once downloading is complete, you start execution of the code by using Lucifer's 'g' command. And at last the board plays Jingle Bells!

Various approaches

As hinted above, there are various different ways of running the cross compiler. This variety also exists within the HPD05 environment. For example, the SOUND program worked so easily because it came supplied with its project file, SOUND.PRJ which provided the MAKE option with all the needed source files (.OBJ and .SYM). If the object or symbol files are



```
≡  Edit  Options  Optimization  Compile  Make  Run  Help  Utility
┌ SOUND.C ─────────────────────────┐ DOS command ...        alt-D
#include        <stdio.h>
#include        <68hc05e0.h>          Debugger ...           alt-B
#include        <intrpt.h>            Download ...           alt-L
#include        <math.h>
                                      Debugger setup ...
/*                                    Auto download after compile
 *      Link this code with C05 option "-R" or
 *      "Initialized data in RAM" enabled, as it
 *      and CHANGE_VECTOR macros to dynamically modify interrupt
 *      vectors at runtime.
 *
 *      This code is set up to run on a standard HI-TECH Software
Line 1/241 Col 1 Insert Indent                 < Search F2 >

┌ Message ─────────────────────────────────────
Compilation successful
Internal RAM:  $0030 - $0078     $0049 (73) bytes
Extended RAM:  $0200 - $0266     $0067 (103) bytes
Program ROM:   $1000 - $20F6     $10F7 (4343) bytes
ROM Vectors:   $7FF0 - $7FFF     $0010 (16) bytes
```

This HPD screen dump shows the compiled code about to be downloaded to the 68HC05 micro-controller chip ('Run' menu). The start of the 'Sound' C program is shown at left, while some of the messages from compiling the hex code appear at the bottom. The various windows are able to be expanded on the screen to display more of their contents.

missing, MAKE will not work. However, you can use a REMAKE option to do the compiling and linking, and then create the .HEX code. Alternatively, this process can be done instead with the COMPILE menu. This allows compiling to .OBJ code which is machine independent, or compiling and linking to produce executable code for the selected target microprocessor.

The .PRJ files are ASCII files, and so can be easily modified — unlike the .OBJ and .SYM files which are in a proprietary form.

The HPD05 editor

The HPD (Hi-Tech Professional Development) system has a built-in text editor for the creation and modification of C source code. It is loosely based on the Wordstar word-processor, with commands for block operations, for keyboard cursor movements, insert/delete, search and standard file (save, quit, etc.) operations. It also supports mouse-driven clipboard cut and paste.

Because the 6805 processor does not have an addressable stack, Hi-Tech C uses a *compiled stack* to pre-assign static memory addresses to all local variables and function arguments. A complete set of standard libraries are provided, including implementation of <stdio.h> routines printf( ), sprintf( ), scanf( ) and sscanf( ). To reduce code size, this library does not support 'long' and 'float' formats, but an additional library is supplied which does support them.

The Lucifer debugger

As mentioned earlier, the Lucifer debugger gives you control over your microcontroller code via the host computer, once you have produced the hex and symbol files. The Lucifer command set includes sufficient choices to edit and debug your code. It even includes an 'A' command to activate a 6805 'mini-assembler' which is built into the system. This allows you to enter small programs or edit downloaded ones. A complementary 'U' command disassembles machine instructions.

All the standard commands are provided. These include commands such as set, display or remove breakpoints; step, trace and execute code; display assembler instruction and C source line currently being addressed; examine the C source code; display a hex dump of the memory contents in the target system, etc. In short, everything is supported to let you edit and debug your code.

Summarising

The ability to write, test and debug code for embedded control on a host machine with a different microprocessor is extremely useful. The 68HC05 cross compiler program seems to us to allow a programmer to do just this, and very easily. Due to time restrictions, we did not try out all the specific commands available for the processor and the debugger; but the overall operation was easy to master.

Hi-Tech offer quite a few cross compilers, especially for MS-DOS host machines. These range from the Z80 up to the 80486. The recommended retail price for the 68HC05 version (and most of the other for MS-DOS) is $695.

Our review copy came direct from Hi-Tech Software, whose postal address is PO Box 103, Alderley 4051; phone (07) 300 5011, fax 300 5246. ❖

Silicon Valley NEWSLETTER

Sculley signs on at Cellular Data

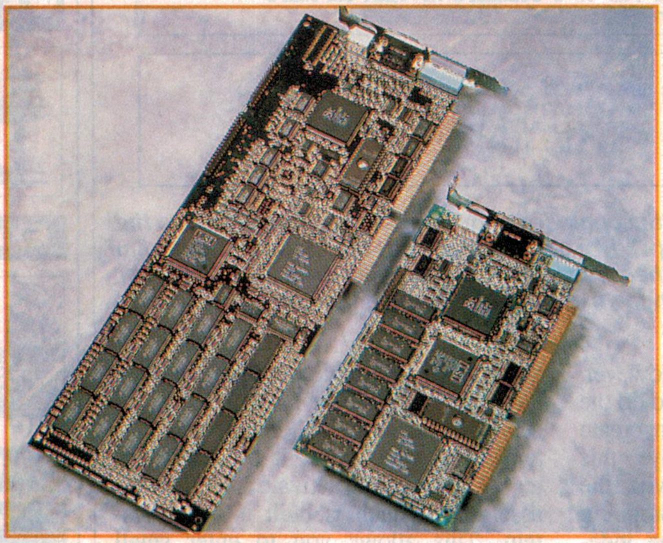
Three days after announcing his resignation from Apple Computer in mid-October, John Sculley signed on as chairman and chief executive officer of Spectrum Information Technologies, a nine year old US$100 million-a-year Manhasset (New York) company which is developing products to allow portable computers to transmit large quantities of data over cellular telephone networks. Spectrum lost US$6.8 million in 1992 on sales of US$100 million.

Sculley told a news conference that he was enthusiastic about becoming part of a company that is working to help build the 'data superhighway' system. He said he believes Spectrum will become the Microsoft of wireless data communications technology, and that its name will become as much a household brand name as Microsoft and Intel.

"This company is a gem, and well positioned with unique technology in the booming data transmission wireless world," Sculley said. "I am tremendously impressed with Spectrum founder Peter Caserta and his vision for building Spectrum as a foundation for explosive growth." Scully has taken an undisclosed equity position in Spectrum. The company would not say how much it will be paying him. He routinely made more than US$10 million in salary, bonuses and stock options at Apple.

Spectrum has several key patents for transmitting data in small packets over cellular telephone lines. The company has developed the first commercially available cellular modem. Spectrum has licensed some of its technology to Rockwell International, AT&T, and McCaw Communications, and received its latest patent for 'Direct Connect' technology which links cellular telephones directly to portable computers without requiring a separate third unit.

Sculley indicated he expects his new company to be doing business with Apple, in licensing its data transmission technology to Apple to be used in the Newton and Powerbook products.



American based video-graphics specialist Matrox has recently introduced what is claimed to be the world's first 64-bit graphics cards for IBM compatible PCs, the MGA Impression and MGA Ultima. The MGA Impression has 3MB of RAM and with twice the bandwidth of existing 32-bit cards, has achieved a score of 60 Winmarks on the new Winbench 3.11 benchmark program. (Available in Australia from TCG, on (02) 699 8300.)

Intel to put ID tags on microprocessors

Stunned by a fast growing number of armed robberies and other theft cases targetted at its valuable microprocessors, Intel has announced plans to put serial numbers on each of its microprocessor chips — making the Santa Clara company the first chip maker to put ID numbers on its products.

While there have been cases reported in different areas of the United States and around the world, Silicon Valley has been the scene of more than a dozen Hollywood-style armed robberies in which the perpetrators often got away with several hundred thousand dollars worth of Intel microprocessors.

The Intel announcement came four days after the latest attack, which took place at TEG Microtechnology in Fremont. A group of armed robbers tied up the employees of the small electronics contract manufacturer and forced the president of the company to hand over an estimated US$500,000 in Intel 486 chips.

Only weeks previously, two similar robberies took place in Milpitas — netting the robbers, armed with automatic rifles, more than US$300,000. And last week robbers fled after the owner of an electronics shop tripped his company's burglar alarm when ordered by the robbers to turn it off. The owner narrowly escaped death when one of the robbers, angered by the sound of the alarm, put his gun to the owner's head and pulled the trigger. Fortunately, the gun didn't go off.

The rush of microprocessor chip thefts has been escalating during the past year. Almost all attacks are aimed at places that have large volumes of Intel microprocessors in inventory.

The chips are the ideal black market products, being small, light in weight, unmarked and highly valuable. At US$300 to US$900 per chip, the processors are worth several times their weight in gold or platinum. And there is a huge number of 'grey market' dealers eagerly purchasing any Intel chips being offered.

"The straw that broke the camel's back for us was the fact that people's lives are being threatened by these armed robbers," said Intel spokesman John Raffrey. "We believe our customers' problem has become our problem. This (ID tags) seems like the responsible thing to do."

By adding a serial number on each chip, it will be possible for authorities to determine whether batches of processors are in the possession of the rightful owner.

Grey market dealers suspected of purchasing Intel processors may be targetted for raids, and may for the first time face charges of at least possession of stolen property.

Apple to sell CD-ROMs at cost

In a radical move to vastly broaden the use of CD-ROM drives, Apple Computer is to sell about one million of its CD-ROM drives at the company's cost — a move which will cost Apple US$100 million in profits, by selling software directly to users instead of through retail outlets.

Apple said that by foregoing the profit it could earn on the sale of its CD-ROM drives, the company will be able to quickly sell an estimated one million CD-ROM drives during the current fiscal year. That compares to 48,000 units sold two years ago. By the end of this fiscal year, there will be some 1.2 million CD-ROM-based Macintosh machines out in the market, out of a worldwide total of about seven million PC CD-ROM drives. About one in every two new Macintoshes sold today is equipped with a CD-ROM drive.

Apple believes that this 'seeding the market' with CD-ROM will allow the company to accelerate sales and profits from multimedia software and hardware products.

Increasingly CD-ROM discs are being used to market application software, and Apple want to play a leading role in this trend. As part of the program to start selling software directly to the public, Apple said it will distribute Macintosh applications programs on CD-ROM discs containing as many as 100 application programs.

The discs will allow users to experiment with the software to see if they meet their requirements. To purchase the program, users simply call a toll-free number and pay by credit card. Apple then provides the user with a special code to unlock that particular program on the CD-ROM disc, so the user can transfer the software onto his hard disk drive.

Electronic newspaper from Microsoft, Dow

Microsoft has made a bold move in the direction of the personal digital assistant market by teaming up with Dow Jones & Co, publishers of the *Wall Street Journal*, to deliver an online news, stock quotes, and weather update service to a new generation of mobile communications devices which are expected to be introduced by Compaq, Toshiba, Motorola and others by mid 1994.

Those devices will be based on Microsoft's new 'Microsoft at Work' software concept, which ties a variety of office systems, such as faxes, telephones, copiers, and printers together into an intelligent network.

The new Microsoft service will be known as *Personal Journal*. Microsoft will include the access software for the service with every copy of 'Microsoft at Work'. Users will then be able to buy a subscription to *Personal Journal* from Dow Jones, which said the daily cost will be competitive with the 75¢ newstand price of the *Wall Street Journal*.

This is how *Personal Journal* works. As early as 11pm, users will be able to dial a toll-free number and download the contents of the next day's *Wall Street Journal* into their PDA. Throughout the day, users can also call in to receive updates on earlier stories. The news and other material will be presented in the familiar *Wall Street Journal* format. Unlike the hard copy available from newstands, the *Personal Journal* can be customised. 'Readers' can search the large volume of articles by search names, such as the names of companies, key people, or products. They can also request to see the closing prices of a customised portfolio of companies.

For Dow Jones, the entrance into the embryonic world of mobile communications/computer devices is a natural extension of a number of earlier investments into the age of electronic data communications. Already the company offers a *JournalFax* service and provides the full text of the *Wall Street Journal* to desktop computers via a service called 'DowVision'.

David Packard retires after 54 year career

For all of its 54 year history, Hewlett-Packard has had just one chairman of the board: co-founder David Packard. But recently the 81-year old Packard, with his partner Bill Hewlett and hundreds of family members and business associates at his side, announced his retirement.

Taking over as chairman is Lewis Platt, a 27-year H-P veteran who took over last year as president and chief executive officer. Along with Packard, four other long time directors retired from H-P's board. Among the new directors are Packard's daughter Susan Orr, and Hewlett's son-in-law, Jean-Paul Gimon.

Explaining his decision to call it quits, Packard said his company is now running the way it should. Three years ago, Packard, who had not been actively involved in the day-to-day operations of his company for more than a decade, stepped in to restructure the firm, having seen the operation drift off course from its historic emphasis on innovation and commitment to the unique employer-employee culture known simply around Silicon Valley, as 'The H-P Way'.

As part of the restructuring program, Packard eliminated an entire level of middle management, restructured the firm's operating divisions and reshuffled the top management team. With H-P back on its historical track of strong sales and earnings growth, Packard's final mission was completed. "I am convinced that we have done that (the turn around) and that is why I've decided to retire at this time." Packard said.

With his retirement, Packard leaves an enormous legacy behind — a legacy that has its roots in a small Palo Alto backyard garage, where two young Stanford graduates started their electronics company and managed to obtain a contract from Disney Studios to build eight of their oscillators to be used in the Disney production of *Fantasia*.

From the garage, which was recently designated as an Historical Landmark, Hewlett-Packard grew into Silicon Valley's premier electronics company, spinning off hundreds of electronics companies in the process and creating Silicon Valley as the centre of America's electronics technology industry.

H-P to experiment with TV printer

It's January 1998. IBM is touting a new ThinkPad computer during the SuperBowl. But in 30 seconds, the TV commercial doesn't give a lot of performance facts. Is it a 120MHz 686, or the new 250MHz 786-based machine? Does it have 64MB or 256MB of DRAM?

For many interested viewers, their interactive TV will be able to provide answers to those and many other questions simply by keying a five digit code, printed on the screen during the commercial, into their TV controllers. Seconds later, the TV's built-in printer spits out a colour brochure about the new machine.

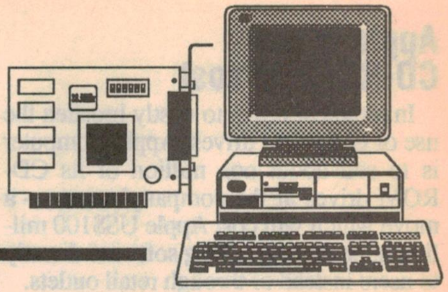
Fantasy? Not if Hewlett-Packard has its way. The Palo Alto company has announced a partnership with cable giant Time Warner, to test the concept of attaching colour printers to television sets in the age of interactive television.

Time Warner is building an experimental 21st century interactive cable TV system in Orlando, Florida, expected to go into service during 1994 in some 4000 homes. Each of these homes will receive an H-P colour printer which will hook up to the TV.

The machine will be able to print out product brochures of products shown on home shopping channels, print coupons, maps, news updates, restaurant menus and magazine articles.

For H-P the move into interactive television is a natural extension of its dominance of the colour printer market. And potentially, the home could end up exceeding the computer market if tens of millions of consumers enter the age of digital interactive TV. ❖

Computer News and New Products



VET Windows Interface

Cybec, Australian authors of VET Anti-Viral Software, are offering the VET Windows Interface to existing customers at a special low price. The interface will enable Windows users to check any incoming diskettes without exiting from Windows. This convenience will make virus control easy to even the novice PC user.

VET has always offered superior boot sector protection, along with a fast scanning speed. Using the program through the Windows Interface does not compromise any of the features which have made VET so successful. The normal cost of a single user Interface is $50, but for a limited time is being offered to existing customers at $35. Educational and Site Licences are also available.

For further information circle 162 on the reader service coupon or contact Cybec, 3/350 Hampton Street, Hampton 3188; phone (03) 521 0655, fax 521 0727.

Output VGA to VCR/TV

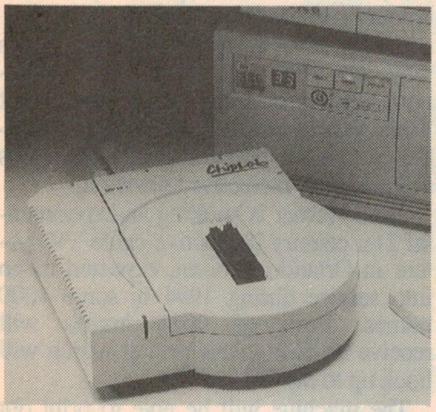
Designed for education, marketing, and sales presentations, the Telb model 701 videoverter comes in a compact 50 x 89 x 25mm box that fits in your pocket. Any PC that has a VGA graphics adaptor card can use the Videoverter to produce low cost custom videos on any standard video cassette recorder, or display first class presentations on a large screen TV.

The Model 701N (NTSC) and 701P (PAL) versions of the Videoverter offer the following features: LCD/TV display toggling; TV auto blanking; display size and position adjustment; interlaced/non-interlaced mode display, with 11 VGA display modes, up to 256 colours; and compatibility with Microsoft Windows, Lotus 1-2-3, Animator, and CAD. As the Model 701 Videoverter is completely software independent, it is suitable for use in almost any application.

For further information circle 164 on the reader service coupon or contact Boston Technology, PO Box 1750, North Sydney 2059; phone (02) 955 4765, fax 955 4468.

Low cost programmer

DATA I/O has designed and manufactured a low cost programmer, ideal for the design engineer or for small volume programming. Able to program EPROMs, EEPROMs, PROMs, PALs, FPGAs, and micros from DIP to PLCC, SOIC, QFP and TSOP packages, the ChipLab unit is a valuable prototyping tool for designers.



The programmer performs load, program, verify, sumcheck, ID test, illegal bit test, blank check, erase of electrically erasable devices, continuity check and PLD testing to 4ns speed. Its menu driven user interface makes it easy to operate from a PC and it has a built-in full screen editor for editing EPROM data in Hex and ASCII format.

Interfacing to virtually any IBM-compatible parallel port means access to an expansion slot is not required. This makes it suitable for laptop and notebook applications.

ChipLab operates from its own filtered power supply or from a 24V DC 1.3A source. Its 1500-plus algorithms are Vendor approved, and perform continuity check on all devices as well as providing PLD vector testing. Updating via BBS is also available.

For more information circle 170 on the reader service coupon or contact Nilsen Instruments, PO Box 30, Concord 2137; phone (02) 736 2888, fax 736 3005.

Z80 C cross compiler

Hi-Tech Software has released a new version of its Z80 C cross compiler. New features include full support for up to 1MB of code using bank switching. This can be used on Zilog Z180 or Hitachi 64180 processors, as well as other Z80 based chips with external bank switching hardware.

The Z80 processor and its derivatives have been in use for many years, but with new versions of the chips being released at a steady rate, shows no sign of dying. This latest Hi-Tech release allows the computer to make full use of the expanded memory space of current versions.

For further information circle 165 on the reader service coupon or contact Hi-Tech Software, PO Box 103, Alderley 4051; phone (07) 300 5011, fax 300 5246.

600dpi laser has Windows GDI driver

Dataproducts Corporation has released a new printer that claims to significantly improve printing using Microsoft Windows. The Dataproducts LZR 888 is a low cost, RISC based, 8ppm personal desktop laser printer with FastPrint, Dataproducts' unique Windows Graphical Design Interface (GDI) device driver, and 600dpi resolution with Phototone.

GDI is the software used by Windows to generate or 'rasterise' the font and graphic images that appear on the user's screen. With its GDI FastPrint driver, the new Dataproducts LZR 888 takes the rasterised information directly from Windows via a high speed IEEE 1284 bi-directional interface, and prints exactly what is on the screen. No time consuming conversion to a page control language (like HP PCL or Adobe PostScript) is necessary, ensuring faster printing. By incorporating FastPrint, the LZR 888 requires no fonts, using instead the host computers' TrueType or ATM fonts for true WYSIWYG printing.

Also GDI, like PostScript, is printer independent, which means that the image will match the resolution of the output device, the higher the device resolution the better the image quality. Dataproducts' FastPrint driver also incorporates 'RamSaver' technology, which compresses the file in GDI mode permitting higher speed transfers and the reduction of printer memory requirements.

While quoted at 600dpi resolution, Dataproducts have implemented a sophisticated half-tone screening process in the LZR 888, called Phototone. Operable in GDI mode, Phototone creates 16 grey scales per pixel on a 300 x 600dpi grid. The output is claimed to be comparable to that of a 1200dpi printer and achieves 256 shades of grey up to 106lpi screen frequency. The LZR 888's use of ultra-fine (eight micron) toner helps with the resolution of fine point size and thin lines.

Dataproducts is including a standard HP PCL-5e driver with the LZR 888, which ships with 26 resident PCL fonts, (compatible with the HP LJ4) scalable from one to 999 points. In PCL mode the LZR 888 prints at 300 or 600dpi, and emulation sensing detects whether a GDI or PCL file is being transmitted and switches mode accordingly.

The LZR 888 features an Intel i80960 RISC processor running at 32MHz, a single or dual bin configuration for up to 500 sheets, and a compact footprint of 365 x 330mm for desktop use.

For the environmentally conscious the LZR 888 incorporates a power saving mode, shutting down the mirror motor and reducing fuser temperature after reaching the preset inactivity level.

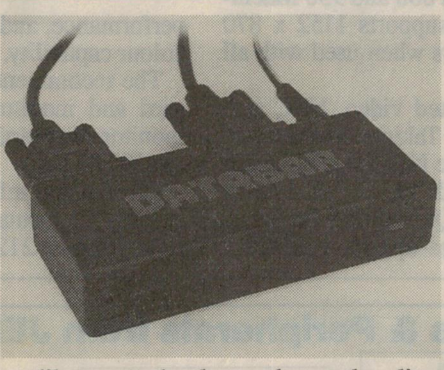
The LZR 888 is available now from Dataproducts' nationwide dealer channel, at a recommended retail price of $2195 (excluding tax), for the single bin model with 2MB of memory. Options

Bar-code decoder

The Databar Model 850 Decoder accepts input from any type of bar code scanner, or magnetic stripe head, making it more powerful than a simple bar code reader. It can also accept serial RS-232C data from instruments such as scales, OCR readers and portable terminals, and will convert the data to IBM AT keyboard scan codes.

The user can easily configure the decoder by scanning bar code menus, and specify terminator, preamble and postamble, enable and disable codes, establish length tests, specify RS-232 parameters, and set the host computer type. The choice of hosts include IBM and compatible PCs, IBM and Wang terminals, serial ASCII terminals and Macintosh.

An optional 'Portable Pack' battery module allows the user to take the Model 850 Decoder off-line for data collection away from the computer. This makes the decoder ideal for such tasks



as library stock takes and record audits, or anywhere that portable use is a secondary task.

Designed and manufactured in Australia, the decoder uses all surface mount components and a multi-layer board to ensure a high level of reliability within one compact package.

For further information circle 171 on the reader service coupon or contact Databar Bar Code Systems, PO Box 300, Brookvale 2100; phone (02) 938 4994, fax 938 5730.

include a dual bin version and user installable SIMM memory to a maximum of 10MB.

For further information circle 180 on the reader service card or contact Dataproducts Corporation, 10 Rodborough Road, Frenchs Forest 2086; phone (02) 451 3533, fax 975 1652.

Waveform acquisition and analysis for Macs

SuperScope II is a new generation of waveform acquisition, analysis, and presentation software for the Apple Macintosh Computer. Released by GW Instruments, this software instrumentation design environment enables end users to build powerful computer based instruments in relatively little time — with no programming experience necessary.

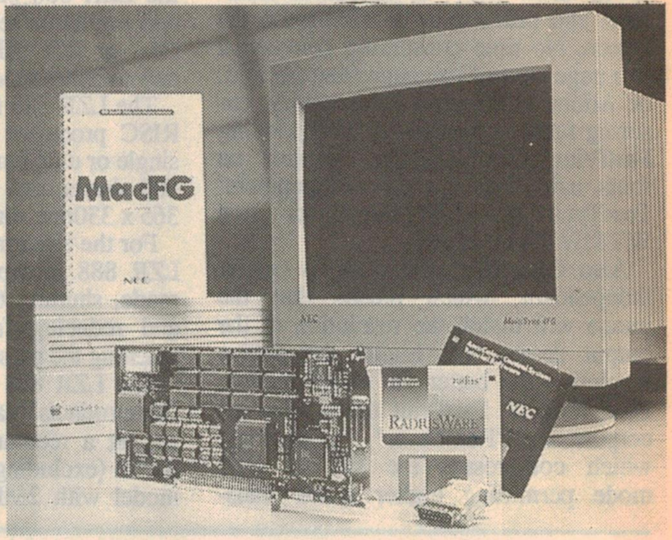
When used with GW Instruments' MacADIOS family of Macintosh-compatible data acquisition and control hardware, SuperScope II is claimed to be ideal for such applications as scientific research, industrial measurement and control, medical monitoring, and manufacturing.

The software can create virtual instruments with displays, text windows, switches, meters, knobs, buttons, dials, lights, and thermometers. It can also digitise, analyse, plot and store to disk continuous streams or discrete blocks of waveform data (i.e., 'strip chart' or 'oscilloscope' mode). Its extensive waveform arithmetic and analysis has over 80 waveform functions which include spectrum analysis, filters and trigonometric. The user can extend the program with BASIC, C, Pascal or FORTRAN routines.

The base SuperScope II package sells for $1490, while the entry level version which does not allow programming of pulse analysis, filter and advanced waveform functions, costs $750.

For further information circle 173 on the reader service coupon or contact MacScience, PO Box 211, Heidelberg 3084; phone (03) 499 2607, fax 499 4977.

NEC video adaptors for Mac users



NEC Home Electronics Australia has released a range of video cable adaptors, enabling its 15" to 21" FG MultiSync monitor range to work with all Apple Macintosh computers up to 1152 x 870 resolution. NEC also announced its 24-bit, 16.8 million colour, accelerated display interface card to complement the 15" and 17" FG series monitors.

The adaptors convert the industry standard VGA connector found on the NEC FG series monitors to the video connector on the Macintosh, wired for the appropriate resolution. There are five models in the range of adaptors; the FGMAC supports the basic 640 x 480 mode on all monitors and computers; the 832PB supports 832 x 624 mode on all monitors with the Mac PowerBook computers; and the 832 with all NEC monitors and other Mac computers, again at 832 x 624. For higher resolutions the FGMAC 1024 adaptor supports 1024 x 768 mode on the NEC 17" 5FG and 5FGe, and the 21" 6FG monitor with the Mac Centris and Quadra 800 and 950 Macintosh models. Lastly the FGMAC 1152 supports 1152 x 870 mode on the NEC 5FG and 6FG monitors when used with all Mac Centris and Quadra computers.

For Macintosh users needing accelerated video, NEC also released its MacFG 24Xp interface card. Taking advantage of Apple's 32 bit QuickDraw technology, the NEC MacFG 24Xp colour display interface card works with Macintosh NuBus computers, including the Macintosh II, Quadra and Performa 600 series. The MacFG 24Xp card gives optimum graphics performance, and provides the user with an accelerated 24-bit colour capability.

The recommended retail prices (including tax) for the NEC card and monitor systems range from the NEC 3FGe 15" monitor plus card at $2160, to the 5FG 17" monitor plus card at $3937.

For further information circle 161 on the reader service coupon or contact NEC Home Electronics, 244 Beecroft Road, Epping 2121; phone (02) 868 1811, fax 869 1112.

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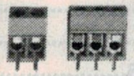
NEW BITS & BOBS

Modular PCB Terminal Blocks

Comes in two and three terminal configurations which can be locked together with no loss of pitch. Make any size of terminal block you need on a 5mm pitch. Accepts wires up to 1.5mm dia approx.

Two post 60c
Three post 90c



D9/RJ45 Network Adaptor

Handy for networks adapts a D9 plug to RJ45 Socket. Configure how you like using the 8 jumper leads provided. **$7.95**

Crimp 90° BNC Connectors

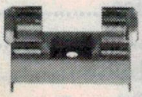
A new addition to our extensive BNC range is a crimp version of the 90° BNC connector **$12.40**

IC Extractor

Convenient spring-loaded tweezer type action. **$9.50**

SCSI Terminators

Essential for proper working of SCSI systems **$22.95**
We carry a comprehensive range of SCSI accessories for both Macintosh and IBM



PC Mounted Fuse Holders

Takes the miniature M205 (20mm) type of fuse **40c**

Hakko 926 Soldering Station

The Hakko 926 is a super-quick heat-up (3 sec cycle) and fast recovery iron offering high quality soldering at lower tip temperatures. The built-in ceramic heater maintains temperature to within 0.5°C of the setting. Yes this is an ADJUSTABLE temperature iron covering the range from 200°C to 480°C using a full wave zero-crossing switching system. Meets MIL-STD-2000 and operates at safe 24V.
Also available in ESD for antistatic environments. We stock a wide range of tips to suit. Ask for listing. **$183.95**

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- *Extra tough for industrial users*
- *High energy fuse and PTC protection against overloading*
- *O-ring sealed case, switch and jacks against dirt and moisture*
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- *Test probes have finger shields and sleeved plugs*
- *Thick walled ABS case and shock mounted LCD withstands 2m drop on to concrete floor*
- *Unique rotary switch with berylium copper contacts and gold plated pcb*

Model 103 & 105

- 4000 count
- Data hold & Relative functions
- 0.1% (105) or 0.5% (103) dc accuracy
- 8 functions inc frequency and capacitance

APPA

Appa 88	$ 94.80*
Appa 91	$118.80*
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Appa 98	$214.80*
Appa 103	$298.80*
Appa 105	$358.80*
Appa 76 Component Tester	$142.80*
Appa 35 Clamp Meter	$142.80*

* Call for Tax-Free prices

LM1875 25W amp IC
See Sil Chip Dec 93 $4.40

Analog Panel Meters

We carry a wide range of analog meters for projects, instruments etc. If you have a requirement not listed ask and we'll locate something suitable.

- *SEW meter movements*
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- *High precision jewel and pivot suspensions*

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ST-65-1A-DC	67x67mm Panel Meter	20.25
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ST-65-10A-DC	67x67mm Panel Meter	20.25
ST-65-20A-DC	67x67mm Panel Meter	20.25
ST-65-30A-DC	67x67mm Panel Meter	20.25
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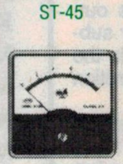
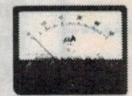
ST-670-10V-DC	70X60mm Panel Meter	20.30
ST-670-20V-DC	70x60mm Panel Meter	20.30
ST-670-30A-AC	70x60mm Panel Meter	20.30
ST-670-30A-DC	70x60mm Panel Meter	20.30
ST-670-30V-DC	70x60mm Panel Meter	20.30
ST-670-100uA-DC	70x60mm Panel Meter	20.30
ST-670-300V-AC	70x60mm Panel Meter	20.30


ST-38


ST-45


ST-65


ST-70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NEW Electrowipes

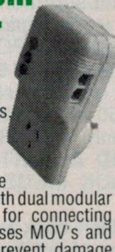
These lint-free cloths come impregnated with electronic grade solvents for cleaning edge connectors, switch contacts etc. They are individually packed in sachet form for perfect cleanliness every time. Solvents evaporate to leave a clean dry surface.
Three types, 10 sachets per pack :
IPA Isopropylalcohol solvent for switches and edge connectors etc Flammable **$7.50**
Gold contact lubricant improves conductivity and increases lifetime dramatically **$12.50**
ECS Electronic cleaning solvent non-toxic, non-flammable for delicate components, will not harm surrounding plastic parts **$12.50**
We carry a range of Electrolube products in hobby and professional quantities. Call us with your requirements

QUV-T8/N Industrial EPROM Eraser

- *Erases 15 in 20-30mins.*
- *Takes PCBs up to 200x125x25mm.*
- *Anti-static slide out tray*
- *UV indicator*
- *15,000microwatt/sq cm*
- *Safety interlock switch*

$167.10 ex tax $195.20 inc tax

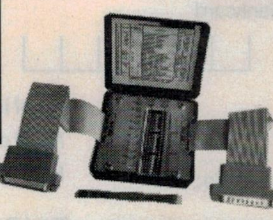
Fax/Modem Protector



Protects delicate equipment from both power surges and lightning strikes. Also indicates correct wiring and earthing of power point. Simple in-line 240V installation with dual modular telephone sockets for connecting fax, modem etc. Uses MOV's and gas arrestors to prevent damage which may costs $100's to fix. Excellent value at **$60.75**

RS232 In-Line Break-Out Box

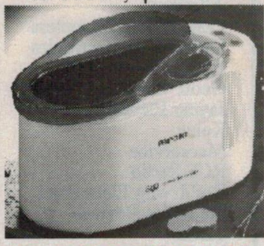
Simplest way to check any 25-pin "D"Series RS232 circuit – input, output or cabling! No external power and has flexible connecting leads. 10 tri-colour signal powered LEDs monitor and indicate standard circuit activities. 2 extra LEDs for miscellaneous lines. 24 DIP switches to cut out and configure lines and circuits. Spring terminals allow patching in to any of the 24 active lines for external monitoring. Supplied with 20 jumper wires. Pocket-sized 85x95x30mm with 80mm leads. Value at **$59.95**



Ultrasonic Cleaner

The latest high-tech way to clean PCB's, switches, watches, drafting pens - even your dentures! Let the millions of tiny cavitation bubbles clean the surface 40000 times per second. 165x90x50mm container holds half a litre and is made of 304 stainless steel. Some people are charging a lot more.

Our's are only **$199.00**

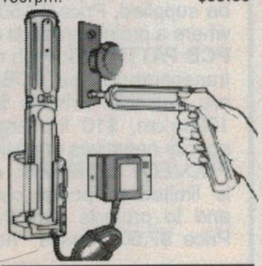


GPS-3030 30V,3A Power Supply

Economical compact laboratory DC power supply with 0-30V output at up to 3A which can be floated either side of earth. Fine and coarse voltage control for accurate setting. Analog meters show voltage and current. Full overload and short circuit protection. Low ripple (0.5mV typ) and 0.2% regulation. 12 month warranty. Excellent value **$360**

Cordless Screwdriver

Features a dial that sets the clutch from 4 to 21kg-cm depending on the job in hand. Folds so you can hold like a torch or a power drill. Uses standard collet type bits and the handle holds your two favourites (comes with standard flat and Philips head bits).
Supplied with stand and charger. 35mm dia (approx) x 255mm long. Max torque 25kg-cm, No-load speed 180rpm. **$58.80**



NEW Parallel Data Cable

What's the easiest way to pass data between 2 PC's?
With our new CC21 cable! Simply connect the two printer ports and, using the latest version of DOS, you're away. What could be simpler? Ideal for Laplink in parallel mode.
Cable CC-21 25pin male DB25 to 25pin male connectors. 1.8m long approx. Why pay $30?
Our's are only **$19.95**

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Mail Orders add $5.00 min to cover postal charges.
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Which of our many advertisers are most likely to be able to sell you that special component, instrument, kit or tool? It's not always easy to decide, because they can't advertise all of their product lines each month. Also some are wholesalers and don't sell to the public. The table below is published as a special service to EA readers, as a guide to the main products sold by our retail advertisers. For address information see the advertisements in this or other recent issues.

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KEY TO CODING:
A Kits and modules
B Tools
C PC boards and supplies
D Components
E IC chips and semiconductors
F Test and measuring instruments
G Reference books

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ADVERTISING INDEX

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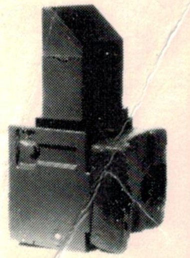
IR VIEWER "TANK SET"

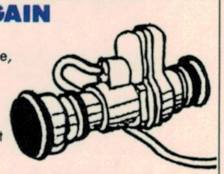


ON SPECIAL is a set of components that can be used to make a complete first generation Infra Red night viewer. These matching lenses tubes and eyepieces were removed from working tank viewers, and we also supply a suitable EHT power supply for the particular tube supplied. This power supply may be ready made or in kit form: Basic instructions provided. The resultant viewer requires IR illumination.

$180

We can also supply the complete monocular "Tank viewer" for the same price, or a binocular viewer for $280. "Ring"

PASSIVE NIGHT VIEWER BARGAIN

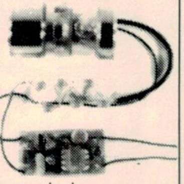


This kit is based on a BRAND NEW passive night vision scope, which is completely assembled and has an EHT coaxial cable connected. This assembly employs a high gain passibe tube which is made in Russia. It has a very high luminous gain, and the resultant viewer will produce useful pictures in sub-moonlight illumination. The viewer can also be assisted with infra red illumination in more difficult situations. It needs an EHT power supply to make it functional, and we supply a suitable supply and its casing in kit form. This would probably represent the best value passive night viewer that we ever offered! BECAUSE OF A SPECIAL PURCHASE OF THE RUSSIAN SCOPES WE HAVE REDUCED THE PRICE FROM $550 TO A RIDICULOUS:

$399

This combination will be soon published as a project in E.A. NOTE THE REDUCED PRICE: LIMITED SUPPLY. Previous purchasers of the above kit please contact us.

INFRA RED TUBE AND SUPPLY



These are the key components needed for making an INFRA RED NIGHT VIEWER. The tubes will convert infra red light into visible light on the phosphur screen. These are prefocussed tubes similar to type 6929: Do not require a focus voltage. Very small: 34mm diameter, 68mm long. All that is needed to make the tube operational is a low current EHT power supply, which we provide ready made or in kit form: powered by a 9V battery and typically draws 20mA. INCREDIBLE PRICING:

$90

For the image converter tube and an EHT power supply kit! All that is needed to make a complete IR night viewer is a lens, an eyepiece and a case. See E.A. May and Sept. 1990.

24V DC TO MAINS VOLTAGE INVERTERS

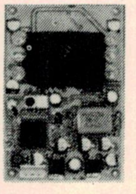
In the form of UNINTERRUPTABLE POWER SUPPLIES (UPSs). These units contain a 300W, 24V DC to 240V-50HZ mains inverter. Can be used in solar power systems, etc., or their original intended purpose of UPSs. THESE ARE VERY COMPACT, HIGH QUALITY UPSs. They feature a 300W-450W (50HZ) SINE WAVE INVERTER. The inverter is powered by two series 12V-6.5AHr (24V) batteries that are built into the unit. There is only one catch: Because these NEW units have been in storage for a while, we cannot guarantee the two batteries for any period of time, but we will guarantee that the batteries will perform in the UPSs when these are supplied. We will provide a three month warranty on the UPSs, but not the batteries. A circuit will also be provided.

PRICED AT A FRACTION OF THEIR REAL VALUE: BE QUICK!

LIMITED STOCK!

$239

CCD SECURITY CAMERA

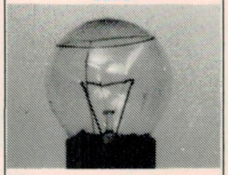


Miniature security camera. Overall dimensions are 24 X 46 X 70mm and it weighs less than 40 grams! Auto Iris lens, 0.1Lux sensitivity, IR responsive, 12V DC operation, standard CCIR video output. Can be connected to a VCR.

$239

We have suitable 12V monitors available for **$60-$100.**

PLASMA BALL KIT

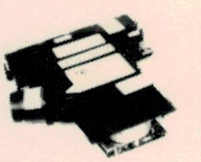


This kit will produce a fascinating colourful changing high voltage discharge in a standard domestic light bulb. The EHT circuit is powered from a 12V supply and draws a low 0.7A. We provide a solder masked and screened PCB, all the onboard components (Flyback transformer included), and the instructions at a SPECIAL introductory price of:

$25

We do not supply the standard light bulb or any casing. The prototype supply was housed in a large Coffee jar, with the lamp mounted on the lid: A very attractive low cost housing!! Diagrams included.

LASER SCANNER ASSEMBLIES



These are complete laser scanners as used in laser printers. Include a IR laser diode optics and a very useful polygon scanner (motor-mirror). Produces a "fan" of light (approx 30 deg) in one plane from any laser beam. We provide information on polygon scanner only. Clearance:

$60

LIGHT PIPE

Used flexible "Light pipe". The core is highly transmissive to visible and IR light and has a diameter of 5mm! Can be used with high level light sources. Suitable for medical use with lasers, illumination of small areas (microscopes), fascinating demonstration of fibre optic links with LEDs-detectors, etc. Original cost is approximately $35 per metre!

$3 per metre

MINI EL-CHEAPO LASER

A very small kit inverter that employs a switch mode power supply. Very efficient! Will power a 1mW tube with a 12V battery whilst consuming about 600mA! Excellent for high brightness laser sights, laser pointers etc. Comes with a compact 1mW laser tube with a maximum dimension of 25mm diameter and an overall length of 150mm. The power supply will have overall dimensions of 40 x 40 x 140mm, making for a very compact combination.

$59

For a used 1mW tube plus the kit inverter.

ATTENTION ALL MOTOROLA MICRO-PROCESSOR PROGRAMMERS

We have advanced information about two new STATE OF THE ART microprocessors to be released by Motorola: 68C705K1 and 68HC705J1. The chips are fully functional micros containing EPROM/OTPROM and RAM.

Some of the features of these new LOW COST chips include:

- **16 pin DIL for the 68HC705K1 chip**
- **20 pin DIL for the 68HC705J1 chip**
- **10 fully programmable bi-directional I/O lines**
- **EPROM and RAM on chip**
- **Fully static operation with over 4MHz operating speed.**

These two chips should become very popular. We have put together a SPECIAL PACKAGE that includes a number of components that enable "playing" with the abovementioned new chips, and also some of the older chips.

IN THIS PACKAGE YOU WILL GET:

- **One very large (330 X 220mm) PCB for the Computer/Trainer published in EA Sept. 93, one 16X2 LCD character display to suit, and one adaptor PCB to suit the 68HC705C8.**
- **One small adaptor PCB that mates the programmer in EA Mar. 93 to the "J" chip, plus circuit.**
- **One stand alone programmer PCB for programming the "K" chip plus the circuit and a special transformer to suit.**

THE TOTAL COST OF THE ABOVE PACKAGE IS ON SPECIAL AT A RIDICULOUS PRICE OF:

$99

Note that the four PCB's supplied are all silk screened and solder masked, and have plated through holes. Their value alone would be in excess of $200!! A demonstration disc for the COMPUTER/TRAINER is available for $10. No additional software is currently available.

Previous purchasers of the COMPUTER/TRAINER PCB can get a special credit towards the purchase of the rest of the above package.

LASER OPTICS

The collimating lens set is used to improve the beam (focus) divergence. The ¼ wave plate and the beam splitter are used in holography and experimentation. All are priced at a fraction of their real value:

¼ wave plate (633nM)	**$20**
Collimating lens sets	**$45**
Polarising cube beam splitters	**$65**

GREEN LASER TUBES

We have a limited supply of some 0.5mW GREEN (560nM) He-Ne laser tubes. Because of the relative response of the human eye these appear as bright as about a 2mW red tube: very bright. We will supply this tube and a suitable 12V laser power supply kit for a low:

$299

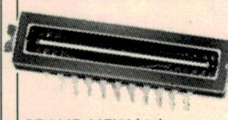
ALUMINIUM TORCHES — INFRA RED LIGHTS

These are high quality heavy duty black anodised aluminium torches that are powered by four "D" cells. Their focussing is adjustable from a spot to a flood. They are water resistant and shock proof. Powered by a krypton bulb. Spare bulb included in cap.

$42

Note that we have available a very high quality INFRA RED FILTER and a RUBBER lens cover that would convert this torch to a good source of IR: $15 extra for the pair.

CCD ELEMENT



BRAND NEW high sensitivity monolythic single line 2048 element image sensors as used in fax machines, optical character recognition and other high resolution imaging applications: Fairchild CCD122. Have usable response in the visible and IR spectrum. Supplied with 21 pages of data and a typical application circuit.

$30

PRECISION STEPPER MOTOR

This precision 4 wire Japanese stepper motor has 1.8 degree steps: That is 200 steps per revolution! 56mm diameter, 40mm high, drive shaft has a diameter of 6mm and is 20mm long, 7.2V-0.6A DC. We have a good, but LIMITED supply of these brand new motors:

$20

HIGH INTENSITY LED's

Narrow angle 5mm red LED's in a clear housing. Have a luminous power output of 550-1000mCD @ 20mA: That's about 1000 times brighter than normal red LED's.

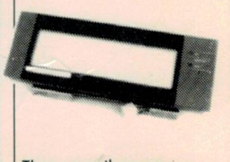
SPECIAL REDUCED PRICE:

50c ea.

or 10 for $4

or 100 for $30

400 X 128 LCD DISPLAY MODULE — HITACHI



These are silver grey Hitachi LM215XB dot matrix displays. They are installed in an attractive housing and a connector is provided. Data for the display is provided. BRAND NEW units at a low:

$40,

OATLEY ELECTRONICS

PO Box 89, Oatley, NSW 2223

Telephone: (02) 579 4985 Fax: (02) 570 7910

MAJOR CARDS ACCEPTED WITH PHONE AND FAX ORDERS

P & P ANYWHERE IN AUSTRALIA

FOR MOST MIXED ORDERS: $2.50-$10

READER INFO NO. 2